MACHINERY

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WATCH MOVEMENT MANUFACTURE*—1

METHODS EMPLOYED BY THE SOUTH BEND WATCH CO.

By DOUGLAS T. HAMILTON†

Fig. 1. Dial View of South Bend "Studebaker" Railroad Watch

A WATCH movement, when we consider its dimensions, the usage to which it is subjected, and the exacting requirements of its performance, is one of the most wonderful pieces of mechanism that man has devised. It may truthfully be called an automatic counting machine, which, with unerring regularity, counts every one-fifth second, day and night, and registers the count in larger units of seconds, minutes and hours on the dial. This is done without human aid, and without the pressing of buttons and the pulling of levers. All that is necessary is to wind up the main spring once in every twenty-four or thirty-six hours.

The South Bend 16 size watch movement shown in Fig. 3, the manufacture of which is to be described in the following, is made in the three-story brick building shown in Fig. 2. The main building is 402 feet long by 33 feet wide. This has several wings and extensions, the entire floor space being 55,220 square feet. All of the movements are made, assembled and tested in this building. The dials are made in a smaller two-story building at the rear. This company employs 500 men and women—most of them experts—and turns out 200 movements per day, quality and not quantity being the main consideration. The cases for the movements are produced by a well-known maker of watch cases, and as a watch is of little value as a timepiece without a case to protect it, some of the methods employed in their manufacture will be described in a future article.

Fig. 2. Factory of the South Bend Watch Co., South Bend, Ind.

Through the courtesy of Mr. C. T. Higginbotham, consulting superintendent of the South Bend Watch Co., South Bend, Ind., the writer is enabled to give a general outline of the methods employed by this company in the manufacture of watch movements. It is not intended that this article shall deal with the construction of a watch, except so far as is necessary to make clear the description of the methods employed in its manufacture. The illustration Fig. 4 is presented for this purpose. With this in view, a description will be given of the various steps followed in designing a new model; that is, a watch which differs in construction from that previously manufactured.

Designing and Making Watch Movements

The first step that is taken in designing a new model is to make all the mathematical calculations for the complete watch movement. These calculations embrace the size and strength of the main spring, the strength and dimensions of the hair spring, and also the balance. Calculations are also worked out to determine the pitch diameters of the wheels and pinions, the number of teeth and leaves and the center distances in the plates and bridges.

After all the calculations pertaining to the various parts of the movement have been completed, an artist's drawing similar to that indicated in Fig. 3 is made. This of no practical value in the manufacturing, except that it gives an idea of what the completed watch will look like. Profile and assembled drawings, plan and developed elevations are then drawn to an enlarged scale. An assembled plan and elevation drawing of the 16 size watch is shown in Fig. 5. The elevations of the complete watch are made in two different scales on the profile drawing—the second drawing made, the first working drawing being a plan view. The developed length is made 10 to 1, and height 50 to 1, which facilitates the laying out of the movement. For the plan views the scale is 10 to 1. The plan and elevation views of the assembled drawing shown in Fig. 5 are made 10 to 1. The developed length of a watch is laid out in the order in which the power is transmitted from the main spring to the escapement, as illustrated in Fig. 4 by the zig-zag dot-and-dash line joining the wheel centers.

From the profile and enlarged drawings the various details are taken and separate sketches of each part are made, giving the number of operations required and the dimensions of the piece after each operation. Upon the completion of all the detail drawings, prints are sent to the model-maker, who, by the use of a transfer chuck, which will be described later, makes a complete model watch. The model maker also makes the master plates, which are steel disks, 1.9 inch in diameter by 0.22 inch thick. In these, are carefully bored holes, exactly 0.1 inch in diameter. The location of every hole, the center of every turning, every curve center, milling, etc., is determined by these holes. The master plates are then used to determine the forms, and relative positions required in all

Fig. 3. Movement of the South Bend "Studebaker" Railroad Watch

* For further information on watch making and allied subjects, see the following articles previously published in MACHINERY, "Watch Crowns, Dies and Methods," December, 1909, engineering edition; "Some Machinery and Methods of Watch Making," July, 1909, engineering edition; "Making Watch Parts in the Commercial Automatic Screw Machine," June, 1908; "Split Die for Watch Regulator," August, 1907; "Watch Dials, Process of Making," February, 1907, page 36, advertising section; "The Watchman's Watch," March, 1904, engineering edition.

† Associate Editor of MACHINERY.

dies, chucks, jigs, and other tools used in the manufacture of the watch. All the curves in watch plates and bridges are made true arcs of circles—no irregular curves being used—so that there is not one part of a watch plate which cannot be produced on the transfer chuck. In order to enable the model-maker to reproduce the form on a greatly reduced scale, the holes in the plates and bridges are laid out in their relation to what are called north, south, east, and west lines, radiating from the center of the watch. These lines are drawn in relation to the pendant which is always north; the position of the east and west in relation to right or left depends on whether the dial is facing up or down. This is illustrated clearly in Fig. 5.

Fig. 6 shows the upper section of a chart of the 16 size, L model watch, open face, which gives the numbers of the holes and the numbers of the master plates in which they may be found. Any hole determining a certain position in a watch always bears the same number, and is frequently placed in two or more master plates. The numbers in the columns are the numbers by which these different master plates are designated. This system enables the model-maker and toolmakers to produce the parts exactly as called for on the drawings.

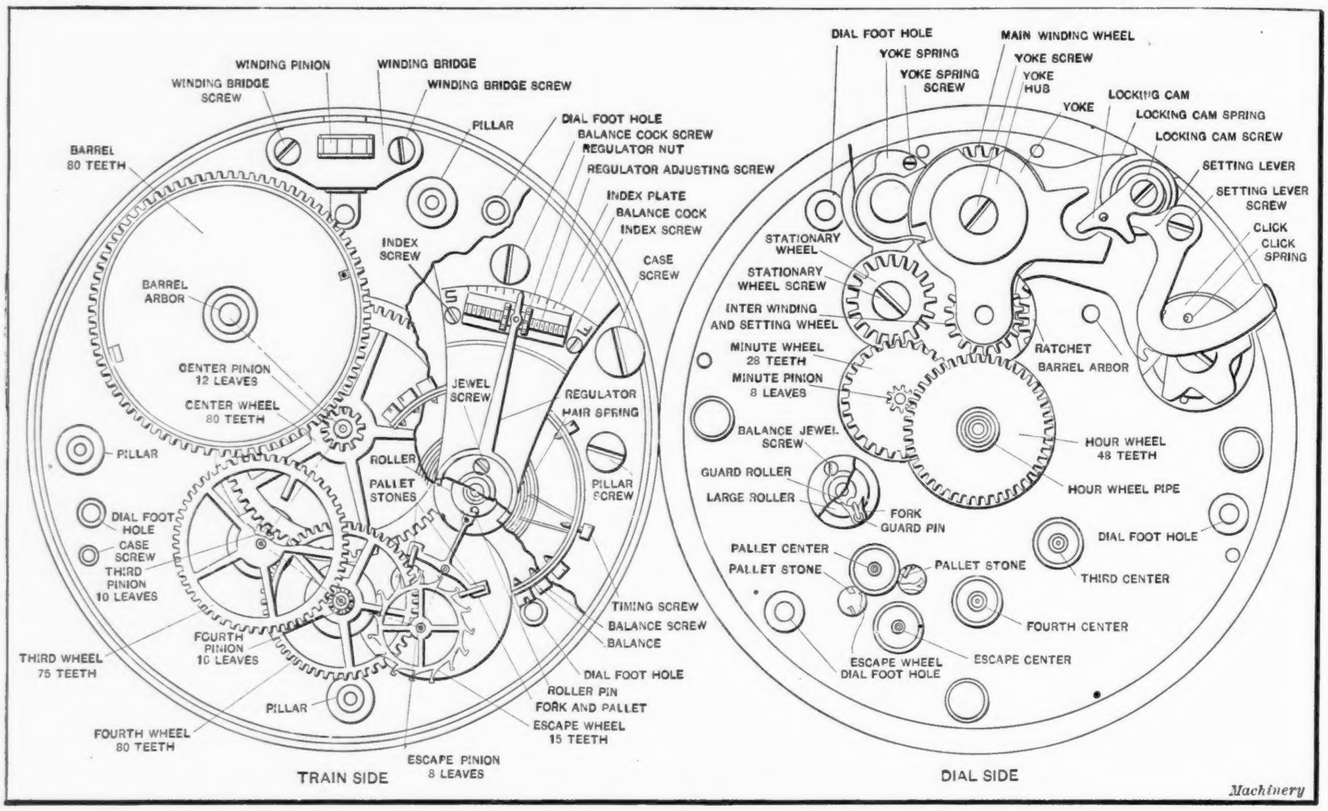


Fig. 4. Dial and Train Side Views giving the Names of the Parts of an 18-size South Bend "Studebaker" Railroad Watch

Fig. 5. Plan and Developed Elevation Views of the 16-size South Bend Watch, Enlarged

The model-maker, by means of the transfer chuck, produces a complete watch which is thoroughly tested. If found to be all that is required as a time-piece of accuracy, the tools for making the various parts are then designed and made. These are sent out into the factory to the various departments in which they are to be used, and the work of making watch movements in quantities on a commercial basis is begun.

Watch Gearing

The calculation for watch gears or wheels, as they are called, is carried out in a slightly different manner from that pursued in the design of gears for other mechanical work. The pitch diameter, and the diametral pitch are calculated in just the same manner, of course, as for any other gear, but the shapes of the teeth of the wheels and the leaves of the pinions differ. The addendum or working face of the tooth is an epicycloid curve starting at the pitch circle and extending to the point of the tooth.

Where the wheel is the driver and the pinion the driven member, the face of the wheel tooth and the flank of the pinion leaves only come in contact. The tops of the pinion leaves are circular for convenience in finishing. These tops never come into action. The wheel tooth and pinion leaf should come into contact on the line of centers to give the best results. To accomplish this, the flanks of the teeth and leaves in the wheel and pinion are made radial with the center. The proper diameter of circle to use for generating the epicycloid curve of a watch wheel tooth is half the diameter of the pitch circle of the pinion with which the wheel is intended to mesh. The addendum is made 2.25 of the diametral pitch for the driver, and 1.0 of the diametral pitch for the driven pinion.

In determining the width of the teeth in the wheel, nine-twentieths of the circular pitch is allowed, and seven-twentieths of the circular pitch for the width of the leaves of the pinion, leaving four-twentieths of the circular pitch for play, which is necessary in watch gearing to obviate dirt stopping the watch. There is no back-lash in watch gearing, because the drive is at all times in one direction.

Watch Train Computations

In laying out a watch train there are certain requirements which must be met. The essentials are, in this watch, that 18,000 vibrations per hour be imparted to the balance wheel, which gives 129,600 vibrations to 7 1/5 turns of the barrel which contains the main spring, and that the intermediate wheels driving the hour, minute and second hands rotate in the correct relation to each other. Another requirement in a railroad watch is that the main spring take 48 hours to unwind.

To proceed with the computation, refer to Fig. 4, which shows the gear train of an 18 size South Bend "Studebaker" railroad watch. The numbers of the leaves in the pinion are first considered, and as practice has determined different sets, we select those most suitable for the case in hand. For instance, the center pinion can have 10, 12 or 14 leaves; the third and fourth pinions 8, 10 or 12 leaves; and the fifth or escape pinion 6, 7 or 8 leaves. The main spring barrel is constructed to make 7 1/5 turns in 48 hours. In this case we select 12 leaves for the center pinion; 10 leaves for the third pinion; 10 leaves for the fourth pinion; and 8 leaves for the escape pinion.

Having decided on the number of leaves in the pinions, the next problem is to find the number of teeth in the barrel and intermediate wheels. The number of teeth in the barrel is:

$$\frac{48 \times 12}{7\,1/5} = 80 \text{ teeth}$$

As the balance wheel is to make 18,000 oscillations to one revolution of the center wheel, and as two oscillations of the balance wheel correspond to one tooth of the escape wheel, the latter having fifteen teeth, it follows, that the escape wheel will make:

Hole No.		Name of Hole	Numbers Designating Master Plates											
	D 1	Dial feet. To left of pendant, dial down	5464	5470	5471	6879	6886	6891		6974		7244	5460	5465
	D 2	Dial feet, E.	5464	5470	5471	6879			6892	6974		7244	5460	5465
	D 3	Dial feet, S. E.	5464	5470	5471	6879	6886	6891	6892	6974		7244	5460	5465
	1	Barrel, N. E.	5464	5470		6879						7244		
	2	Center	5464	5470	5471	6879	6886	6891	6892	6974	6981			
	3	Third, S. W.	5464											
	4	Fourth, S.	5464	5470	5471		6886	6891	6892	6974				
	5	Escape, S. E.	5464											
	6	Pallet, S. E.	5464											
	7	Balance, S. E.	5464								6981			
Other pin No. 12	125–8	Balance cock steady pins, S. E.		5470										
	9	S. E.												
	10													
	11	Balance cock plate screw, N. E.		5470										
Other pins No. 125–8	12	Balance cock steady pin							6892					
	13	Clutch lever screw pendant set, N. E.		5470										
Other pin No. 30	14	Barrel bridge steady pin, N. E.					6886							
Other screw No. 31	15	Case screw, N. E.				6879								
	16	Winding wheel, N.		5470		6879	6886	6891	6892	6974				
	17													
	18													

Fig. 6. Chart of Master-plate Holes for the 16-size Model L, Open Face South Bend Watch

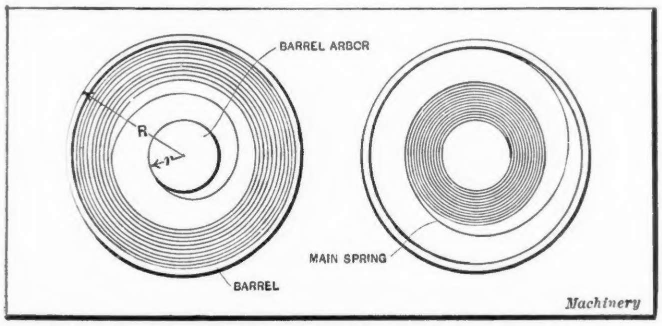


Fig. 7. The Main Spring wound and unwound—Note Space between Arbor and Inside of Chamber

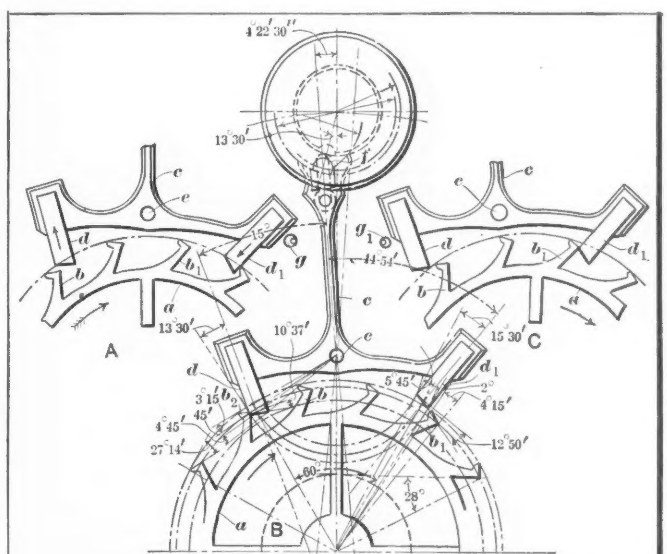


Fig. 8. Diagram illustrating Function and Action of the Detached Lever Escapement

$$\frac{18{,}000}{15 \times 2} = 600 \text{ revolutions per hour.}$$

The fourth wheel which is attached to the second hand must make 60 revolutions per hour, and as the escape pinion has 8 leaves, and makes 600 revolutions per hour, the number of teeth in the fourth wheel equals:

$$\frac{600 \times 8}{60} = 80 \text{ teeth.}$$

The numbers of teeth in the intermediate or third and the center wheels, are in a certain ratio to the number of leaves in the pinions with which they mesh, the product of which ratios must equal 60. The ratio in this case between the fourth pinion and third wheel is 1 to 7½, and between the third pinion and center wheel, 1 to 8. This multiplied by 10 give us, $7\frac{1}{2} \times 10$, or 75 teeth in the third wheel, and 8×10, or 80 teeth in the center wheel; the ratio between the fourth

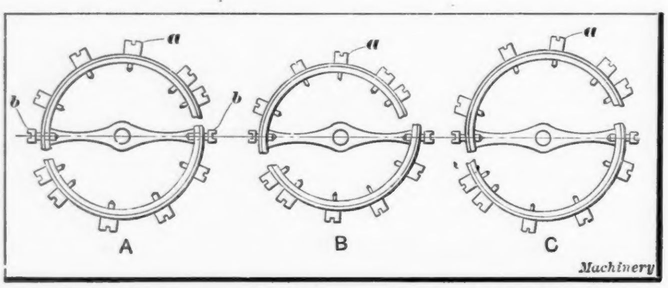


Fig. 9. The Compensating Balance in its Normal Condition and affected by Heat and Cold

wheel and escape pinion is 10. These ratios give the desired relation between the center wheel and escape wheel, the ratio between which is 1 to 600.

The dial train wheels and pinions are now worked out so that the hour and minute hands will be revolved in their proper relation to each other. The dial train is driven by the cannon pinion, which is frictionally held on the center staff. In this case the cannon pinion has 14 leaves, the minute wheel 28 teeth, the minute pinion 8 leaves, and the hour wheel 48 teeth. As the cannon pinion makes one revolution per hour and drives the minute hand direct, it follows that the hour hand will make $\frac{14}{28} \times \frac{8}{48} = \frac{112}{1344} = \frac{1}{12}$ revolution per hour.

The Main Spring

The main spring furnishes the power for driving the entire mechanism of a watch, and is made from the best steel obtainable, carefully hardened and tempered. To give the best action, the main spring has to be made in certain proportions to the barrel or chamber which contains it. The radius r of the barrel arbor, see Fig. 7, is made equal to one-third the radius R of the chamber, the space outside the barrel arbor being divided into two equal areas.* The main spring occupies half this area irrespective of whether it is wound or unwound. Owing to one of the laws governing the action of the main spring, it will give the greatest number of turns when made to these proportions.

The number of turns of the main spring which is necessary to carry the watch a given number of hours is found by the following formula:

$$N = \frac{H \times n_1}{n}$$

in which, N = number of turns of main spring,
H = number of hours the watch is to run,
n = number of teeth in barrel,
n_1 = number of leaves in center pinion.

Applying this formula to the watch shown in Fig. 4, we have:

$$N = \frac{48 \times 12}{80} = 7.2 \text{ or } 7\,1/5 \text{ turns.}$$

The calculations involved in determining the strength and torque of a main spring are too complicated to be presented here; suffice it to say that if the main spring is made to conform to the requirements previously given, thinner or thicker material can be used until a main spring having the proper strength is obtained.

* For further information regarding flat spiral springs, see the article entitled, "The Design of Flat Spiral Springs," which appeared in the July, 1910, number of MACHINERY, engineering edition.

The Detached Lever Escapement

The escapement of a watch movement transforms the rotary motion of the train of wheels into the vibratory motion of the balance. It also acts as a break to prevent the watch mechanism from "running away," retarding the motion of the train, and imparting the proper movement to the hands on the dial. To properly design an escapement, requires considerable study and is considered the most difficult problem in watch movement design. Ideal conditions are impossible to arrive at, so that compromises must always be made if an escapement to suit all requirements is to be obtained.

In action, the escape wheel a, Fig. 8, receives its motion from the wheel train, and by means of its peculiarly shaped teeth b coming in contact with the jewel pallets d and d_1 oscillates the fork c. To illustrate how this action takes place, we will assume that the fork c and escape wheel a are in the positions shown at A.

Now as the escape wheel a revolves, tooth b glides across the face of the pallet d lifting the latter up and forcing the upper portion of fork c, which is fulcrumed at e, to the right. This action lowers pallet d_1, bringing it in contact with the locking face of tooth b_1, as shown at C, and consequently stops the rotation of escape wheel a.

As the upper end of fork c is forced to the right, its forked end carries jewel pin f around, rotating the balance wheel, and putting the hair spring under tension. The hair spring, in unwinding, reverses the rotation of the balance and unlocks the tooth b_1 from the pallet d_1. The instant that this unlocking action takes place, the passage of the tooth b_1 across the inclined face of the pallet d_1 gives another impulse to the balance. This brings the fork and escape wheel into the positions shown at B, which happens as the fork c is returning to the banking g. Tooth b_2 now imparts an impulse to pallet d, and the order of actions is continued. The bankings g and g_1 stop the motion of the fork c in its oscillation from side to side.

The Compensating Balance

The balance wheel, or compensating balance, as it is called, is the heart of the watch. It regulates and controls the movement of the gear train from which it receives its motion. The

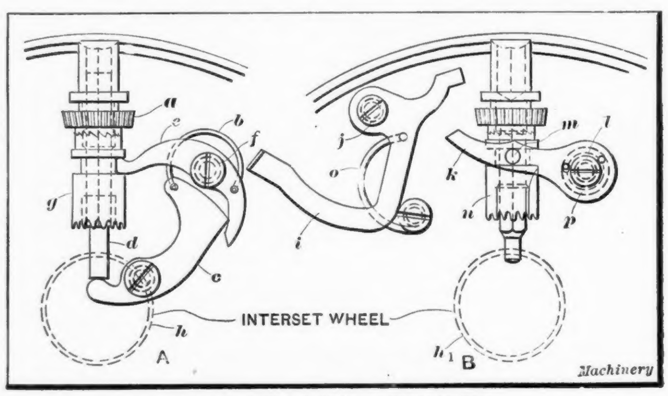


Fig. 10. Watch Setting Mechanisms

motion of the gear train is intermittent, while that of the balance is practically continuous. Five times every second the train starts up from a dead rest, and for a brief space of time moves forward, again coming to rest. In this same time the balance reverses its direction of rotation, stopping for such a brief period of time that the cessation of movement is almost impossible to detect.

A compensating balance is composed of a steel center arm and rim made from one piece of metal, to which a brass ring is fused. The brass ring has twice the coefficient of expansion of the steel rim, and the proportion between the thickness of the rims is approximately two-fifths steel to three-fifths brass. The construction of a compensating balance is clearly shown in Fig. 9. At A it is in its normal position; at B it is affected by heat; and at C by cold. The conditions of the balance are exaggerated here to make the changes in its shape more perceptible. Located around the rim of the balance are what are called "balance" screws a. These are made from either brass

or gold, and are employed for regulating, poising and altering the weight of the balance wheel in relation to the strength of the hair spring. The two screws *b* at each end of the arm are what are known as "timing" screws. These are employed to bring the watch to time without disturbing the regulator, which is always set at zero when it leaves the factory.

When a watch movement is subjected to heat, the tension of the hair spring is decreased and thereby weakened, and the balance arms are lengthened, thus increasing the diameter of the balance which adds to the load on the hair spring. The effect of this action, if not counteracted, would be to cause the watch to lose time. To compensate for this, the brass rim expands more than the steel rim and center, which effect causes the balance to become smaller in diameter tending to throw the mass of its weight more toward the axis, as shown at *B*. When a watch movement is subjected to cold, the hair spring contracts and becomes stronger. The steel rim and center of the balance contract, as does also the brass rim, but as the brass rim contracts more than the steel rim, it has the effect of straightening the rim, thus increasing the diameter of the balance wheel, and carrying the mass of its weight further away from the axis, which has a retarding effect. This condition is shown exaggerated at *C*.

The rim of the balance is provided with more holes than it has screws, so that more screws can be added, or their positions changed as conditions may warrant, when poising and subjecting the movement to temperature tests. These screws add to the weight of the balance and change its radius of gyration, thus compensating for changes in temperature and positions. All first-class watches are regulated for five positions, *viz.*, dial up, dial down, pendant up, and pendant to right and left.

Many ingenious devices have been developed for setting the hands and winding the main spring of a watch. They can,

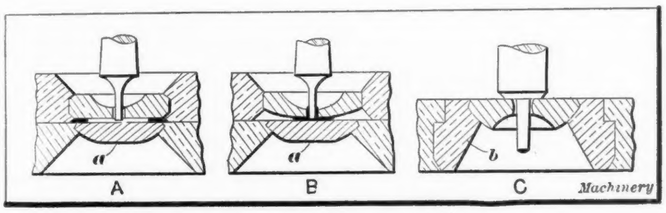


Fig. 11. Jewels, Settings and Pivots

however, be divided into two main classes, *viz.*, pendant and lever sets. A simple pendant and lever set which is used in the South Bend watch is illustrated at *A* and *B* in Fig. 10. At *A* is shown a pendant set mechanism in the position which it occupies when acted upon normally by the stem fastened to the crown, which is used for operating the mechanism. In this position, if the crown were rotated, the main spring would be wound up by means of the winding pinion *a* and intermediate wheels, not shown.

When the crown is pulled out, the stem is withdrawn, releasing the tension on spring *b* and allowing it, through the setting lever *c*, to force up the stem *d*. The spring and lever *c* also act on clutch lever *e*, raising its rear end, and as it is fulcrumed on screw *f*, the forward end is lowered thus carrying down the setting clutch *g*. This clutch, in lowering, meshes with the teeth in an interset wheel *h*, which operates the wheels and pinions connected to the hands on the dial.

The setting mechanism shown at *B* is what is known as a lever set, and is used principally in railroad watches. It is shown in the position that it occupies when the main spring can be wound up by rotating the crown. When setting lever *i*, which is fulcrumed on screw *j*, is withdrawn from the case, its forward end is rotated downward coming in contact with the end of the clutch lever *k*, which is fulcrumed at *l* and connected by a pin *m* to the clutch sleeve *n*. It is evident that this action disconnects the clutch *n* and brings the teeth in its lower end in mesh with the interset wheel h_1, which in turn, operates the hands on the dial. As setting lever *i* is pushed in again, it is returned to its normal position by spring *o*, and as it is released from clutch lever *k*, spring *p* returns this lever to its normal position connecting the clutch with the winding mechanism. With this mechanism it is impossible to set the hands without first pulling out the lever *i;* this is not the case with the mechanism shown at *A*, which is likely to be operated by simply removing the watch from the pocket by the crown, thus making the latter an objectionable mechanism for use in railroad watches.

Jewels

Jewels are introduced into a watch movement to reduce friction as much as possible and also to increase the life of the watch. The shape of the hole in the jewel has a considerable bearing on the reduction of friction and in obtaining the best results. At *A* and *B* in Fig. 11 is shown the incorrect and correct method of finishing the holes in a jewel. The hole in the jewel at *A* is called a "straight hole," having parallel sides and a flat bottom. This type of jewel allows the oil to be drawn between the settings, leaving the jewels dry and keeping the oil at the outer rim, as is clearly shown in the illustration.

At *B* is shown what is called the "olive hole." This reduces the retarding effect of the thickening of oil to a minimum. The face of the jewel has a hemispherical oil cup, and the back is well rounded. The hole is also rounded and is made slightly larger than the diameter of the balance pivot. Having a jewel shaped in this manner increases capillary attraction toward the center, the pivot acting as a piston to keep the supply of oil at this point until the last particle is exhausted. The distance between the hole jewel and its end stone *a* should be just sufficient to allow the interception of a thin oil film. At *C* is shown a common type of jewel for the wheel pivots. This, as shown, is held in a setting *b* and is provided with the olive hole previously mentioned.

* * *

WHY ARE OUR FOUNDRIES NEGLECTED?

In the September, 1911, number of MACHINERY, an editorial appeared, entitled, "Why are our Foundries Neglected?" As an answer to this question we may appropriately quote a few paragraphs from an address by Mr. H. M. Ramp, superintendent of the Modern Foundry Co., before the Superintendents' and Foremen's Club, Oakley, Cincinnati, Ohio. Mr. Ramp says:

"While the foundry deserves much criticism and correction, it has never had the attention, the brains, the research work, or the finances poured in upon it that the machine end of the iron industry has had to elevate and develop its possibilities. It has been considered more as a necessary evil than as a branch of the business that could be mastered and developed and controlled. The foundry, until the last few years, has been the last place to receive improvements and advice, and it is not as yet burdened with a load of either.

"The individual who entered the foundry as a life's business was always regarded as sinking his intellectual or mechanical abilities, if he had any. The foundry has been demeaned and often referred to as a place where the qualifications are 'a strong back and a weak mind,' and yet there is no business under the canopy of heaven that requires greater judgment and a more thorough knowledge of fundamental principles than the art of molding. When properly done it most certainly deserves to be classed as an art, and yet this is the atmosphere in which the foundries of our country were developed and the foundrymen of our country were made until the past few years, while the machine shop was commanding the gray matter and finances of the brightest men in our land. This prejudice against the foundry in the past, as a place of dirt and grime fit only for occupation by hewers of wood and haulers of water, has done much to retard the development of the foundry business and to keep the bright, ambitious and energetic men from mastering its science. But these are not the only reasons why the foundry fails to give the machine shop what it asks.

"When the machine shop seeks to improve its tools or methods, it does not put blacksmiths or candy makers on the job—it uses the best educated brains and experience in the machine business that money can buy. Yet too often the pattern, the very foundation of the foundry's work, is constructed as the designer, the pattern foreman, the engineer directs, without even consulting the experience and preference of the foundry, and in as great a measure as this prevails just as great is the handicap placed upon the foundry."

* * *

The prize of $5000 for an aerial engine, which has been offered by Mr. P. Y. Alexander through the three British aeronautical associations, the Aerial Society, The Aero Club, and the Aerial League of the British Empire, has been awarded to the Green Engine Co., the engine of which developed, during the competition, 61.6 H. P. at 1150 R. P. M. during two non-stop runs of twelve hours each.

RE-CUTTING MILLING CUTTERS WITHOUT ANNEALING

By F. B. JACOBS*

In an article published in the December, 1911, number of MACHINERY the writer outlined the method used in re-cutting ordinary milling cutters without annealing them. In this article the re-cutting of thin milling saws, and of the end teeth of large end-mills will be explained. Great numbers of milling cutters find their way to the scrap box before their days of usefulness are over. These could, at slight expense, be re-cut and put in service again. The saving is especially marked with the high-priced, high-speed steel cutters in common use.

To re-cut milling cutters without annealing them does not call for special skill, or the services of a high-priced tool-maker. All that is required is the ordinary cutter grinding machines found in nearly every tool-room, wheels of the proper materials in the correct grits, grades and bonds, and an operator possessed of a little originality and ordinary mechanical skill. In fact, when re-cutting worn out milling cutters about the same methods are used as when cutting new cutters, except that grinding machinery and abrasive wheels are used in place of the milling machine and milling cutters.

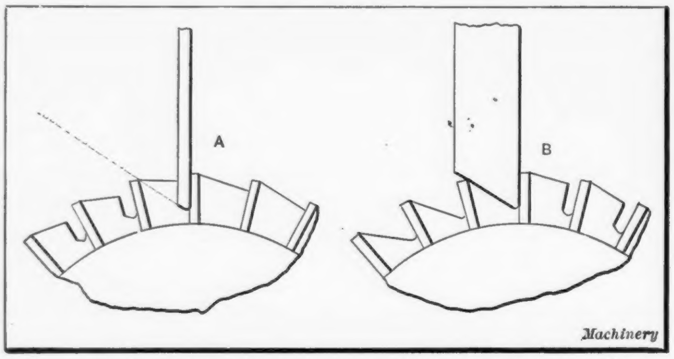


Fig. 1. The Two Steps taken in Re-cutting Milling Cutters by Grinding

The method followed can be readily understood from Fig. 1. This method applies to both peripheral and side teeth. The teeth are first gashed out as shown at *A*, with a thin vulcanite wheel, the object of this gashing being to preserve the corner of the wheel used in the re-cutting operation. At *B* is shown the re-cutting operation, the face of the wheel being trued to the proper angle. To re-cut milling cutters in one operation is not practical, as a hard and, therefore, slow cutting wheel would have to be used to preserve the corner of the wheel. With a thin elastic wheel of just the proper grain and texture for the gashing operation, and a fast cutting vitrified wheel to cut away the superfluous stock between the bottoms of the gashes and the points of the teeth, very economical and satisfactory results can be obtained with a little practice.

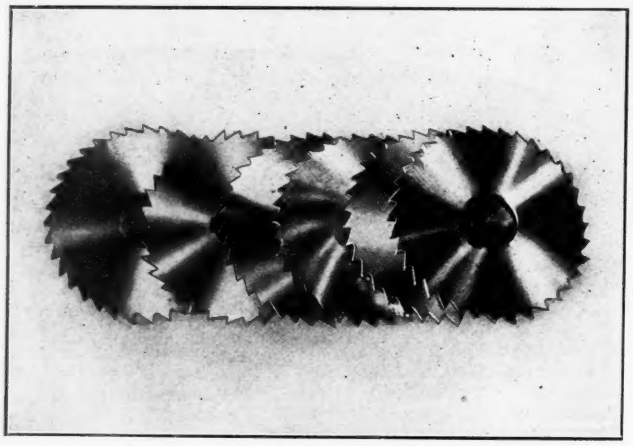


Fig. 2. A Number of Re-cut Slotting Saws

In Fig. 2 are shown six milling saws that for all practical purposes are now as good as new. These, however, were taken from the scrap box; four of them being 4 inches in diameter and 1-16 inch thick, and two of them, 5 inches in diameter and ⅛ inch thick. They were first located on an ordinary work arbor such as used in turning up thin collars, etc., paper washers being placed between the cutters to compensate for the side taper. They were then ground on a Walker grinder to a diameter of 3 9/16 inches. This work was done dry with an aloxite wheel 6 inches in diameter, ½ inch face, 1¼ inch hole, 50 grit, M grade, D496 bond. This operation ground all of the old teeth away from the large saws, and nearly so from the smaller ones.

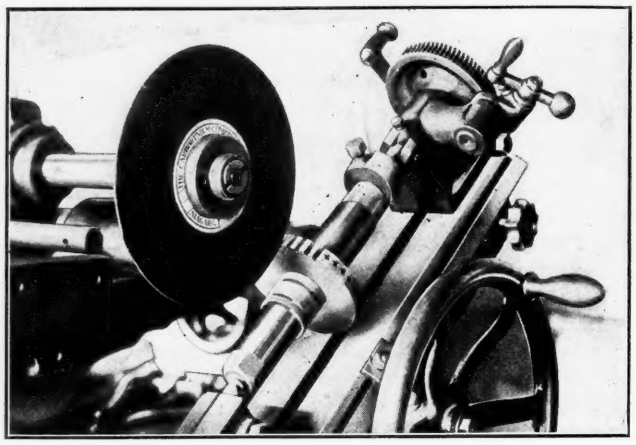


Fig. 3. The Gashing Operation

The work was then placed between the centers of the form cutter attachment of a Brown & Sharpe No. 3 cutter grinder, and the teeth gashed out to the required depth. This operation is shown in Fig. 3. The wheel used for this purpose was aloxite (vulcanite), 7 inches in diameter, ⅛ inch face, 1¼ inch hole, 30 grit, V-K-9 bond, run at a speed of about 4200 R. P. M. In this operation the wheel loss was very slight—only 0.008 inch. The depth of cut was 0.003 inch for each stroke, the graduations on the cross-feed screw being relied on for the correct depth. The work was fed under the wheel with a fairly rapid motion, one tooth being gashed to its full depth at a time.

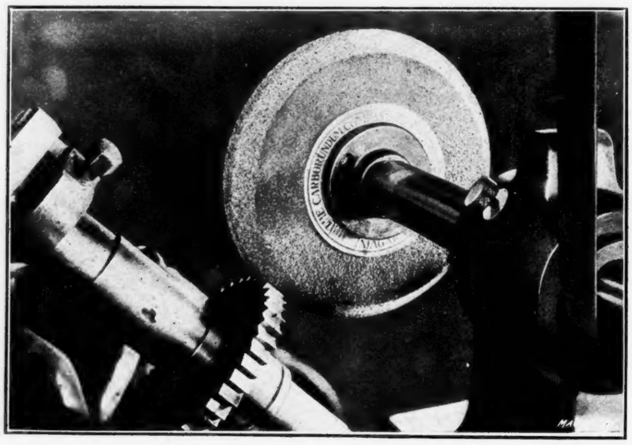


Fig. 4. Cutting the New Teeth

The next operation, which consists of cutting the new teeth, is shown in Fig. 4. This operation is practically the same as the gashing operation, the difference being that a wide wheel is used, its face being trued to the correct angle, as shown at *B* in Fig. 1. The wheel used for this purpose is aloxite, 6 inches in diameter, ¾ inch face, 1¼ inch hole, 40 grit, 0 grade, D497 bond, run at a speed of about 4200 R. P. M. The teeth were fed one at a time under the wheel, taking a cut of 0.002 inch at each stroke until the land of the tooth was of the correct thickness, or about 1/32 inch. The wheel loss in this operation was 1/64 inch. The teeth were then backed off as shown in Fig. 5. For this purpose an aloxite wheel 5 inches in diameter, ⅜ inch face, 1¼ inch hole, 50 grit, 0 grade, D496 bond, was used, the speed being 3650 R. P. M.

The total time consumed in re-cutting these cutters was divided as follows:

* Address: Care of The Carborundum Co., Niagara Falls, N. Y.

Getting ready and setting up for first operation	10 minutes
Grinding time on Walker grinder	30 minutes
Setting up cutter grinder for gashing operation	15 minutes
Gashing out teeth	60 minutes
Setting up for re-cutting operation	5 minutes
Re-cutting teeth	50 minutes
Setting up for backing off teeth	10 minutes
Backing off teeth	13 minutes
Time consumed in truing wheels, etc	10 minutes
Total time	3 hours 23 minutes

In Fig. 6 are shown five high-speed steel end-mills, 3 inches long, 2⅜ inches in diameter, having sixteen teeth each; *A*

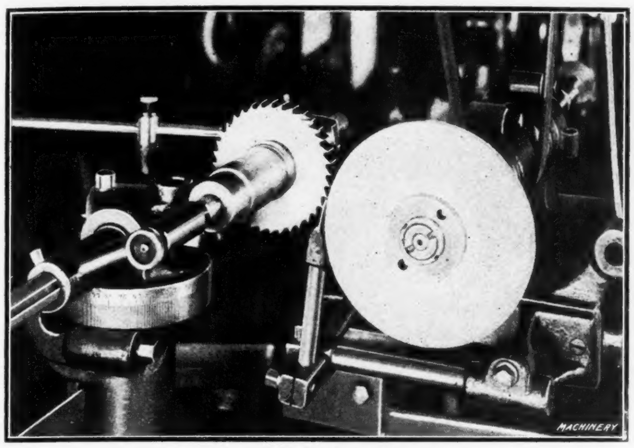


Fig. 5. Grinding the Clearance

shows a mill the end teeth of which are practically worn out, *B* illustrates a mill after the gashing operation, and *C*, *D* and *E* give a good idea of how the mills looked after the second or re-cutting operation.

Before re-cutting, the operator should first decide on the correct angle for the teeth, and then true the face of both wheels to this angle. For this purpose the writer has always used a carborundum stick 9 by ¾ by ¾ inches, 20 grit, H grade. With the wheels in question this will be found more satisfactory than a diamond. In the gashing opera-

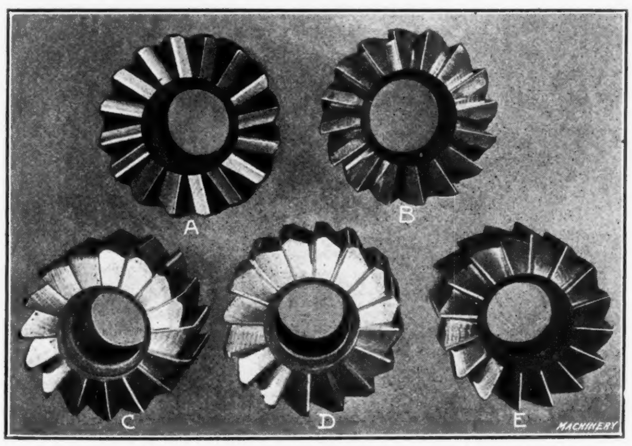


Fig. 6. Various Stages in the Re-cutting of End-mill Teeth

tion the cut should be carried to a depth where a line drawn parallel to the face of the wheel comes nearly to the edge of the tooth. (See *A* in Fig. 1.) In re-cutting end teeth it is necessary to use a machine equipped with a head that can be set at any angle in order to bring the lands of the teeth parallel. The writer used a Brown & Sharpe No. 3 cutter grinder, equipped with an end-mill grinding attachment, as shown in Figs. 7 and 8. In setting the head to the correct angle the cut-and-try method can be used, or the angle can be figured out when the operator has decided on the angle for the wheel face and knows the number of teeth to be cut.*

The gashing operation is shown in Fig. 7, the teeth being fed one at a time under the wheel with a cut of 0.002 inch, until the correct depth is reached. This is easily determined for all of the teeth by the graduations on the cross-slide screw, after the proper depth for the first tooth is decided on. In re-cutting four mills having sixteen teeth each the loss of the gashing wheel was only 1/64 inch. The re-cutting operation is shown in Fig. 8, the teeth being fed

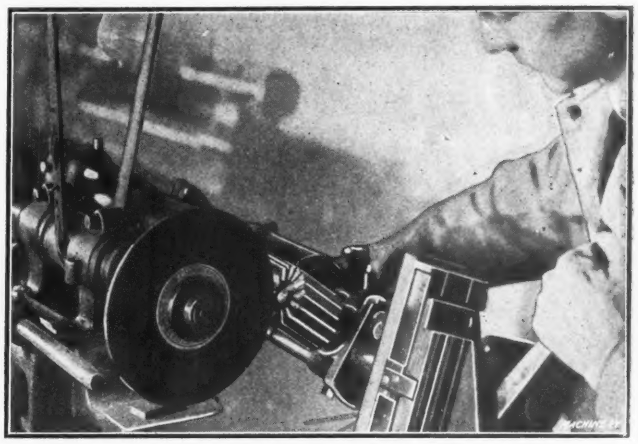


Fig. 7. Gashing the End-mill Teeth

under the wheel until the lands were of the correct dimension, or 1/32 inch. The wheel loss in this operation was ⅛ inch for re-cutting four mills having sixteen teeth each. As the width of the land is relied on in this case to determine the proper depth of the cut, the wheel loss is of no consideration, provided the wheel wears true, thus preserving ap-

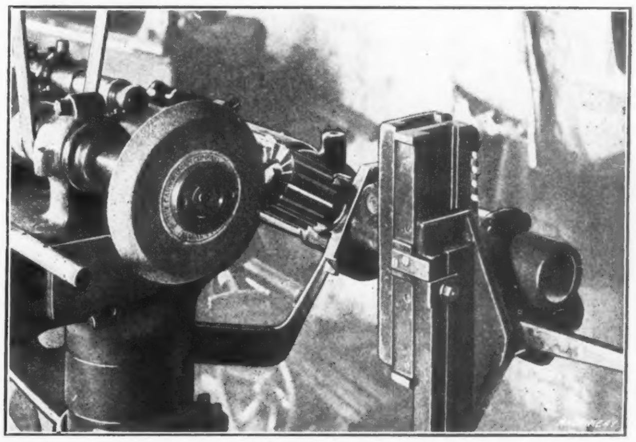


Fig. 8. Cutting the End-mill Teeth

proximately the correct angle. In this operation the most satisfactory results were attained with a soft coarse wheel, run at a comparatively high speed. When finer wheels in harder grades were used the tendency was to cut slow and burn.

After re-cutting, the teeth were backed off as shown in

Fig. 9. Grinding the Clearance on the End-mill Teeth

Fig. 9, this work being done on a Walker grinder equipped with a universal cutter grinding head. The wheel used for this operation was aloxite (cup), 5½ inches in diameter, 2 inches face, 1¼ inch hole, ¾ inch back, ⅜ inch wall, 50

* See MACHINERY, engineering edition, November and December, 1911, "Milling Radial Teeth in Cutter Blanks," and the Data Sheet Supplements accompanying these articles. Also see MACHINERY, April, 1904, "To Calculate the Setting of the Dividing Head when Cutting the Teeth of End-mills"; MACHINERY's Data Sheet No. 32, "Tables of Angles for Headstock of Milling Machine when Cutting End Teeth in Mills, etc."; and MACHINERY's Data Sheet Book No. 4, "Reamers, Sockets, Drills and Milling Cutters," page 32.

grit, 0 grade, D496 bond, run at a speed of about 3650 R. P. M.

The total time consumed in re-cutting four end-mills of the dimensions mentioned above was divided as follows:

Setting up cutter grinder for gashing operation and cutting and trying to determine the correct angle	30 minutes
Gashing out teeth	120 minutes
Re-cutting teeth	120 minutes
Setting up Walker grinder for backing off teeth	15 minutes
Backing off teeth	30 minutes
Time consumed in truing wheels, etc	15 minutes
Total time	5 hours, 30 minutes

As the work as explained was wholly of an experimental nature, it is fair to assume that any machinist of ordinary intelligence could, with a little practice, do the same work in much shorter time. However, for the sake of argument we will suppose that a machinist at thirty cents per hour consumed 8 hours 43 minutes in re-cutting the cutters described in this article. After figuring his time, adding a certain amount for fixed overhead charges, and noting the value of similar cutters as bought on the open market, it will readily be seen that it is more profitable to re-cut them by the method described than it is to sell them as scrap.

* * *

AUTOMATIC BOTTLE BLOWING MACHINES

Automatic machinery for some classes of manufacture has reached a remarkable stage of development. The Owen Bottle Blowing Machine Co., Toledo, Ohio, has glass bottle blowing machines in operation that automatically blow twenty-three ketchup bottles a minute, twenty-four hours a day, seven days a week and fifty-two weeks a year, neglecting the short shut-downs necessary to change the bottle molds. The machine consists of a large turntable carrying two sets of molds, one set being "gathering" molds and the other "bottle" molds. The molds are carried over a hearth filled with molten glass, and as a gathering mold passes over the hearth, a rod of hot glass is drawn into it by suction. The gathering mold opens, leaving a rod of hot glass standing vertically. The bottle mold closes over the gathered glass and air pressure forces the molten glass out to fill the die the same as a glass blower would blow it.

The blown bottle is automatically deposited in a cast-iron bar containing thirty holes in a line. The bar shifts one place for each bottle until it is filled, and then it is taken up by a traveling chain conveyor and carried sideways through an annealing oven. At the far end of the annealing oven two men stand who inspect the bottles and pack them into cases. The cast-iron bars are returned by the chain conveyor to the bottle blowing machine to pass through the same cycle as before.

The bottle molds are made of cast iron and a mold is good for 12,000 to 15,000 gross of bottles before it requires scaling. Compressed air plays an important part in actuating the dies, and natural gas is used for melting the glass. The batch is automatically mixed and fed to the furnace, thus reducing the manual labor required for the operation of a machine and furnace to three men, two of whom are packers. The machine tender regulates the furnace also and looks after the general operation of the apparatus.

* * *

There are more telephones in proportion to population in the United States than in any other country in the world. Canada ranges second in this respect, and Sweden third. It is interesting to note that in New York City alone there are as many telephones as in Germany. In Ohio there are as many as in Great Britain; and Boston has double the number of telephones of Paris. Apparently, most of the European countries have been much slower to appreciate the advantages of the telephone than has the United States. One reason for the slow introduction of the telephone in Berlin, however, is stated to be that the postal system, with its tube post, is so perfected that for less than one cent one can send a message through the mails within the city, receiving a reply within an hour or less.

JIG-BORING AT THE UNITED SHOE MACHINERY CO.'S FACTORY

By CHESTER L. LUCAS*

The illustration Fig. 1 does more to give a general idea of the appearance of the plant of the United Shoe Machinery Co., at Beverly, Mass., than paragraphs of reading matter could do, and as nine-tenths of the employes are machinists, it will be realized that the output of the factory is very large. As a matter of fact, over 20,000 machines for the manufacture of shoes are shipped annually. The plant consists of sixteen buildings of reinforced concrete construction, having twenty-five acres of floor space. Over sixty tons of steel are used each week in the manufacture of machines, and the drop-forging department alone turns out 60,000 forgings per week.

The toolmaking department of this factory is one of the best equipped in the country. The principal work of the toolmaking department is the building of jigs and fixtures, in addition to maintaining the thousands of jigs which are in

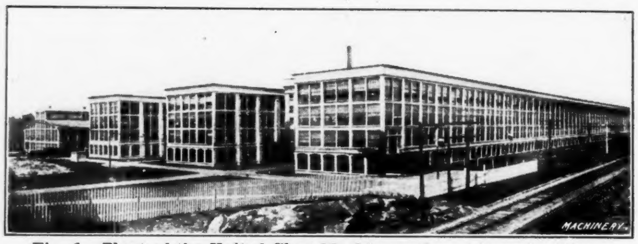


Fig. 1. Plant of the United Shoe Machinery Co., at Beverly, Mass.

daily use in the factory. The important part of the work of jig- and fixture-making is the proper location and boring of the holes for bushings, studs, etc. Fig. 2 shows one of the toolmakers engaged in locating the position of a hole to be bored in the jig shown on the machine. Boring machines made by the Universal Boring Machine Co., Hudson, Mass., are used almost exclusively for boring jigs and fixtures in this factory. As indicated in the illustration, the machines are used without the left-hand supports for the boring-bars. In setting up the work, all measurements are taken either from the table or from an angle-iron that is permanently mounted on the rear part of the table of the machine. This angle-iron, a rear view of which is shown in Fig. 3 (on the floor), is somewhat unusual in type. The ribs at the back are spaced

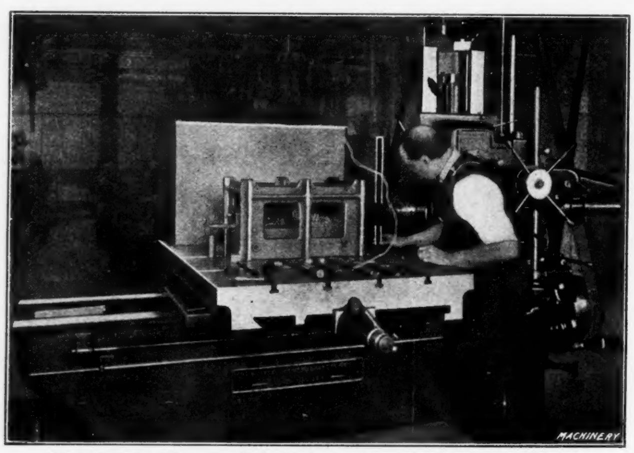


Fig. 2. Locating the Spindle in Position vertically for Boring a Hole in a Jig

very closely, and the angle-iron is clamped to the machine by means of four slots placed between the ribs. The angle-iron shown has been rough-planed, and is now left to "season," before being finished and put into use.

In locating a jig in its proper position on the table of the boring machine, special height-gages are employed. In the toolmaking department there are about twenty-five of these special tools, which are made by the Brown & Sharpe Mfg. Co. These tools have extra wide and heavy bases. The jig is first placed against two stops that may be seen in the left-hand T-slot in the table in Fig. 2. With the height-gage, the jig is placed parallel with the angle-iron on the table, which, of course, is parallel with the spindle of the boring

* Associate Editor of MACHINERY.

machine. In locating the spindle of the machine for boring a hole, measurements are taken vertically from the table, either to the spindle itself, or to a plug which is fitted in the end of the spindle. Needless to say, the spindle must be absolutely without shake or play, and this condition is insured by a "take-up" at the head of the machine. After locating the spindle for the vertical dimension, the horizontal measurement is taken, as shown in Fig. 3, from the angle-iron to the plug or spindle, as the case may be. After the spindle is properly located, the hole is bored for the bushing, and then attention is given to the next hole. Should there be two holes in line with each other on opposite ends or sides of the jig, they are not bored at one setting, as might be supposed, but the jig is reversed on the table of the machine and re-located for the second hole. This method is considered to be the best practice, because long boring-bars are not required, and it is not necessary to use the left-hand boring-bar support. Fig. 4 shows the toolmaker boring the hole in a fixture. The type of machine used is particularly well adapted for jig-boring, because the operator can run the machine with his right hand, and at the same time watch the work of the cutter. It also has an added advantage over machines in which the head is at the opposite end, in that the operator can caliper holes without being obliged to use his left hand in so doing. This same advantage applies, of course, when trying size plugs.

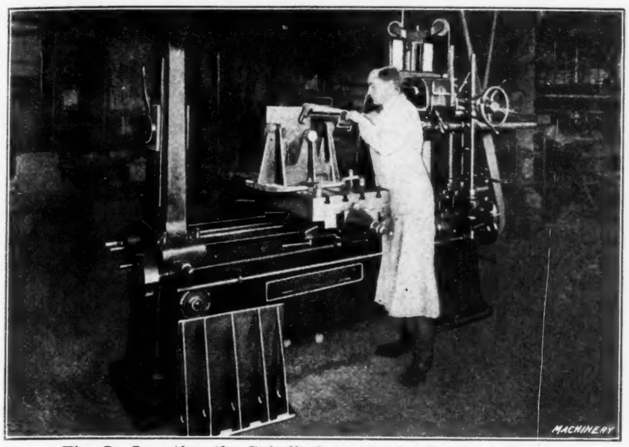


Fig. 3. Locating the Spindle laterally for Boring a Fixture

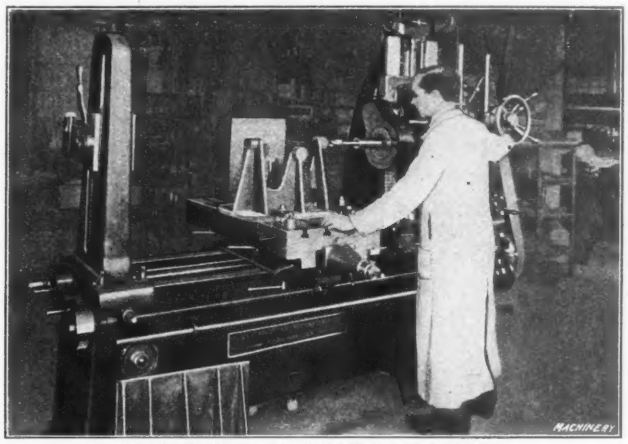


Fig. 4. Drilling one of the Holes in a Fixture

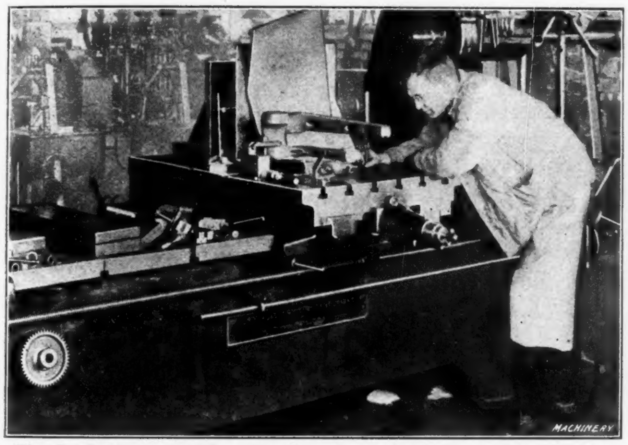


Fig. 5. Setting-up and Locating Experimental Work on Boring Machine

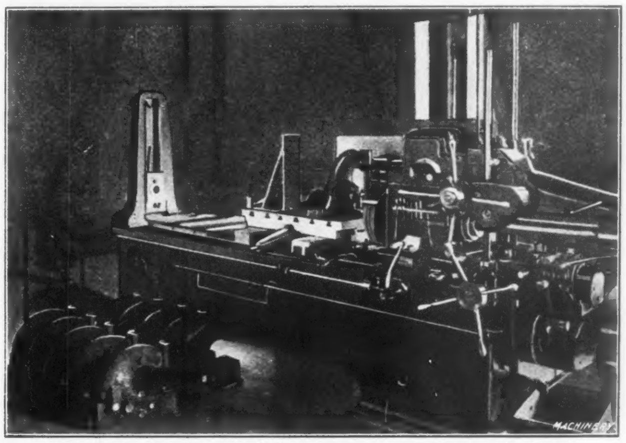


Fig. 6. Boring the Heads for Monogram-embossing Machines

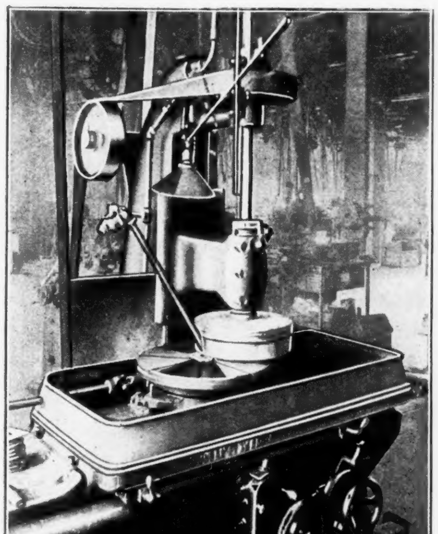


Fig. 7. Face-grinding the Drop-forgings

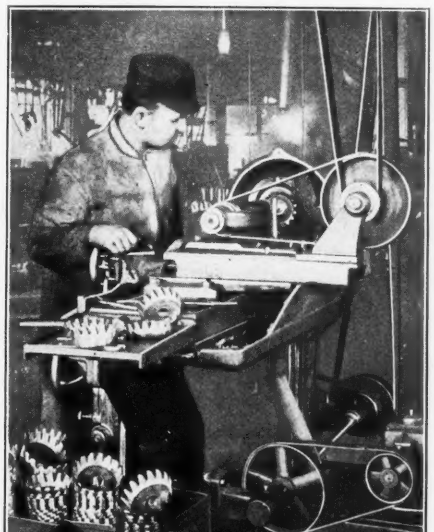


Fig. 8. Grinding Shoe-trimming Cutters

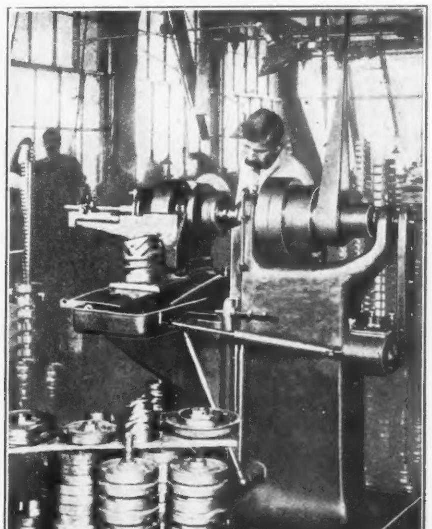


Fig. 9. One of the Cam-cutting Machines

Fig. 5 illustrates the method used in boring work in the experimental department, where trial machines for shoe manufacturing are built in small lots before the work has been

jigged for regular production. The piece shown on the machine is one of the parts of a shoe-leveling machine, and the machinist is setting up the piece and locating each hole to be bored, in accordance with the drawing which he has before him. On a job of this kind it takes a great deal longer to set up the work properly and lay out the positions of the holes than it does to do the actual machining which follows.

The machine in Fig. 6 is shown working on the heads of monogram-embossing machines, a group of which appears on the floor near the base of the boring machine. From the foremost of this group it will be seen that there are numerous

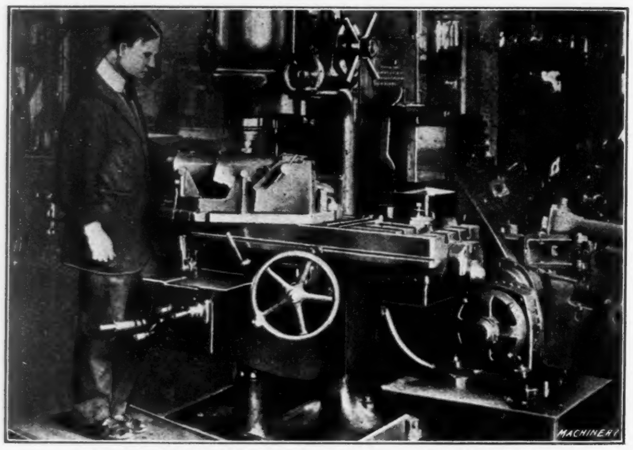


Fig. 10. Milling Fixture for Use on the Vertical Miller

small holes to be located and bored for the various shafts and rocker-arms. This work is essentially the same as in the jig-boring operations, a small angle-iron being used as shown. In this instance, however, the angle-iron is at the side of the table, instead of at the rear.

The Pratt & Whitney Co.'s face grinder shown in Fig. 7 is used extensively in the grinding department for facing small drop forgings, some of which are shown on the machine. The surfaces of these forgings must be parallel within limits of 0.0005 inch. In order to show this machine to better advantage, the water-guard is removed, thus exposing the table to view. The drop forgings, which have central holes, are located by placing them over a stud at the center of the table; a magnetic chuck is not required, for the pressure of the wheel is sufficient to keep the piece flat against the face-plate while it is being ground.

Another interesting grinding job is shown in Fig. 8, where

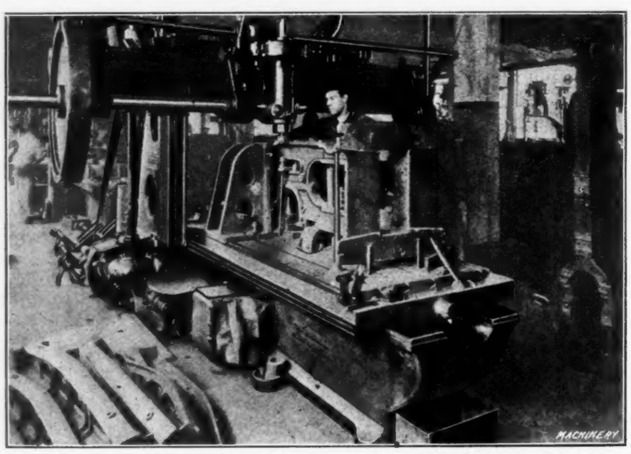


Fig. 11. Milling the Seats and Recesses on a Nailing Machine Column

the knives for shoe trimming machines are ground internally and externally on Heald No. 70 internal grinders. Two machines are used on the work, one being set up for grinding the inside and one for the outside. The machine shown is working on the insides of the cutters, and the same operator, running two machines, turns out two hundred finished cutters per day. The cutters are located by being slipped over a stud that engages the central holes, and are held in place by a nut and washer.

Cams are cut in large numbers and great variety in the United Shoe Machinery Co.'s plant, and a special department is maintained for the sole purpose of turning out the cams used on the various machines. While several makes of cam-cutting machines are employed, the favorite seems to be the machine made by the Kearney & Trecker Co., Milwaukee, Wis. One of these machines is shown in Fig. 9, and some of the various cams which have been cut on it are shown piled up about the machine. Special attention is called to those resting upon the board on the top of the piles in the foreground. This machine, like most other cam-cutting machines, must be provided with a master cam that governs the movements of the work in relation to the cutter.

The Cincinnati miller shown in Fig. 10 is working on tack-puller heads, one of which is shown in the fixture on the table of the machine. As will be noticed, provision is made on the base of the fixture for clamping it in various positions to facilitate the milling of the different parts of the work. It is obvious that it would be impracticable to shift the fixture around in this manner, if the milling being done were other than that of facing off parts in which the relative height is the only consideration.

On the Ingersoll upright type of milling machine shown in Fig. 11 the large columns for nailing-machines are milled to receive the different parts of the machine attached to it. One of these columns is shown at the right of the illustration. This particular job is well suited to this type of machine, because the short cuts that are required can be easily taken with a milling cutter, whereas, if the work were planed, the machine used would necessarily have to be out of all proportion to the amount of cutting to be done, on account of the difficulty of accommodating the extremely large casting.

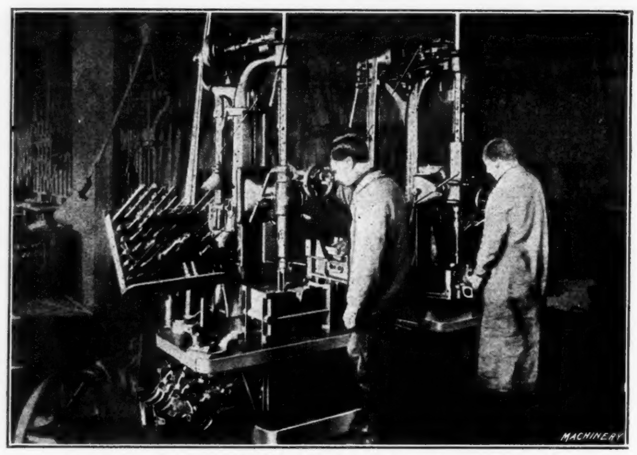


Fig. 12. Racks for Holding Tools used in Drilling Machines

Drilling operations are everywhere to be seen in this large factory, there being hardly a department that does not employ several hundred spindles. The manufacturing work, of course, is all jigged, and to facilitate the many changes which must be made in drills, reamers and counterbores, the large drill presses are fitted with tool-holding racks. In these the different tools used on the job are kept in regular order, so that they may be quickly gotten when wanted. At the same time, they are protected from being injured or mislaid, so that altogether the idea seems to be a good one. Fig. 12 shows a drill press with a rack.

Aside from the work done in the factory, much might be written on the conveniences installed in the factory for the workmen, in the form of metal lockers, washrooms, restaurant, etc. In addition there is a fully equipped emergency hospital. Here a trained attendant is in charge, who is qualified to administer first aid to the injured.

* * *

It appears from an article in *Zeitschrift des Osterreichischen Ingenieur und Architekten-Vereines*, that the water power available for industrial purposes in Switzerland is equivalent to 90 horsepower per square mile. The available water power in Sweden and Norway is about 45 horsepower per square mile of area. In Switzerland, nearly one-quarter of this available water power has already been made use of, while in Sweden and Norway but a small fraction, probably not more than one-fiftieth of the available water power has as yet been harnessed.

DRAWING A DEEP STEEL SHELL*

By JOSEPH V. WOODWORTH†

Fig. 1 shows the six successive operations required to produce the shell shown in Fig. 10, indicating clearly the evolution, proportions and dimensions. The material for which the tools were designed was 0.0359 inch dead soft cold-rolled drawing steel. The shell had to be true to size in diameter and height, smooth inside and out, and a strictly first-class product in every way.

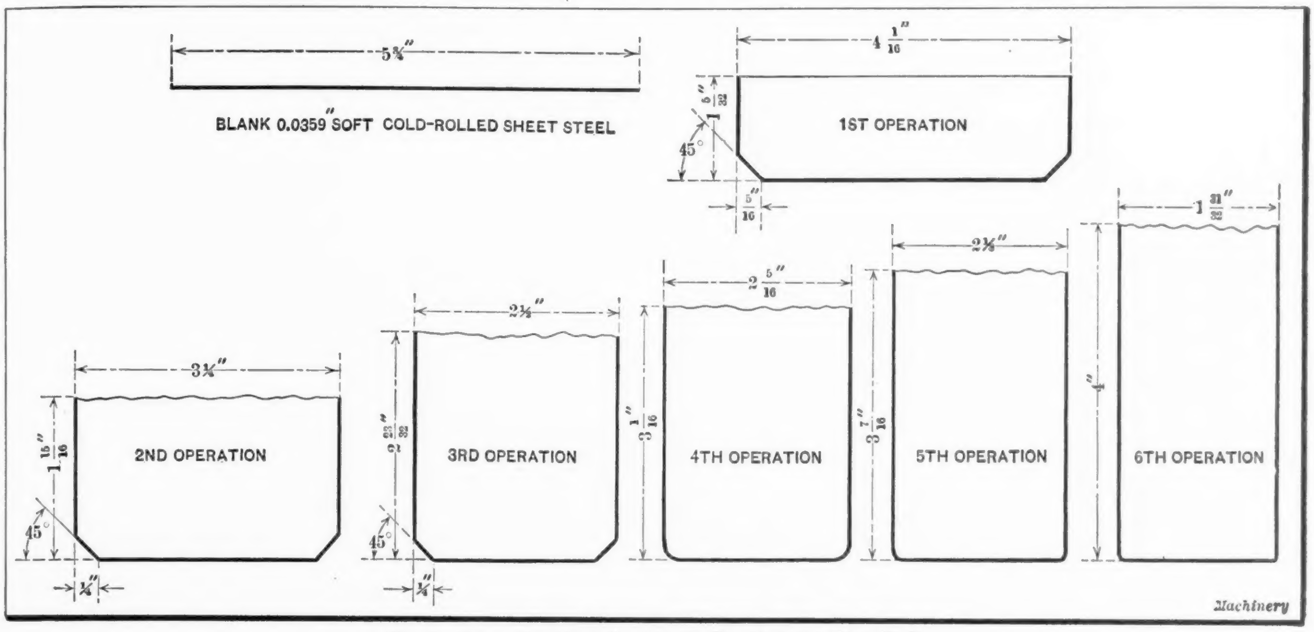
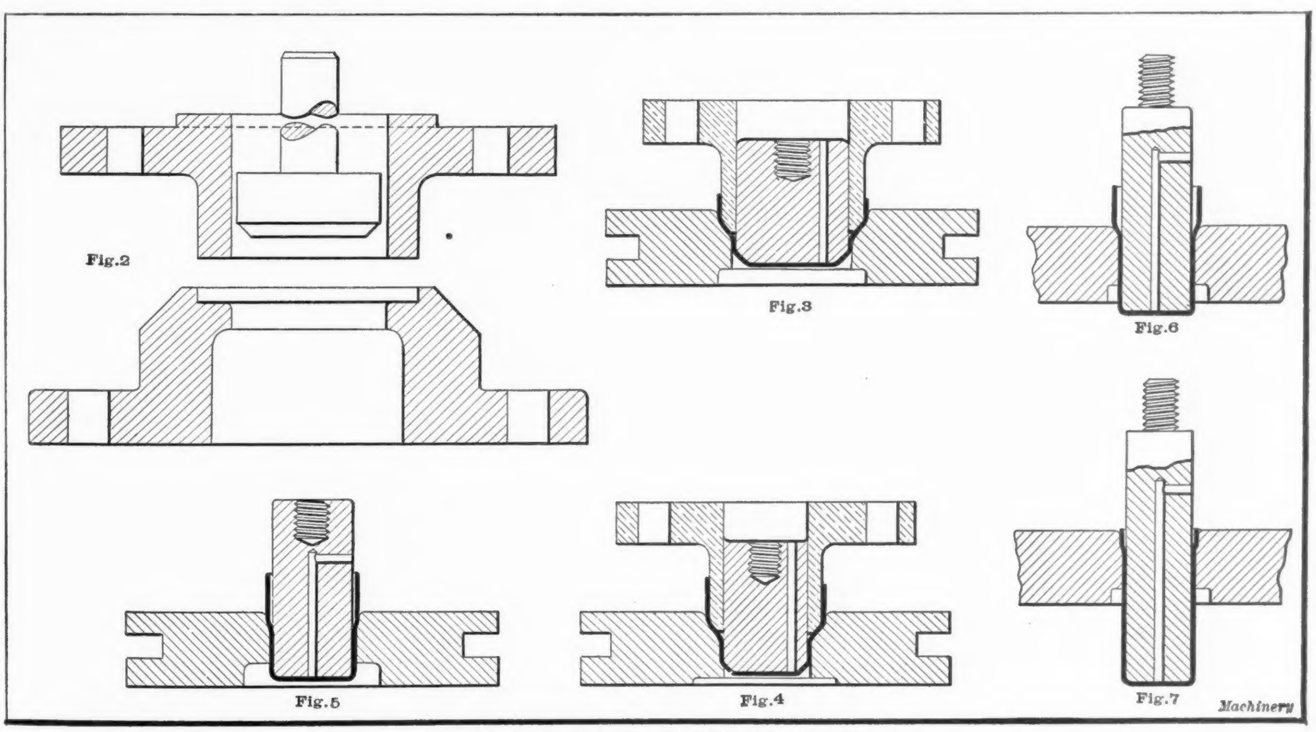


Fig. 1. Successive Operations in the Drawing of a Deep Shell

Fig. 2 shows the double-action blanking and drawing die for the first operation; Fig. 3 shows the tools for the second operation; Fig. 4, the double-action dies for the third operation; Fig. 5, the single-action reducing die for the fourth operation; Fig. 6, tools of the same construction for the fifth operation; and Fig. 7, the punch and die for the sizing and finishing operation. The illustrations show clearly the design, construction and operation of the tools. The shell was annealed four times and trimmed but once—after the last redrawing. A thin mixture of lard oil and white lead was used to lubricate while reducing.



Figs. 2 to 7. Tools for the Operations shown in Fig. 1

* See also MACHINERY, March, 1912, "Drawing a Flanged and Tapered Cylindrical Shell," and the articles there referred to.

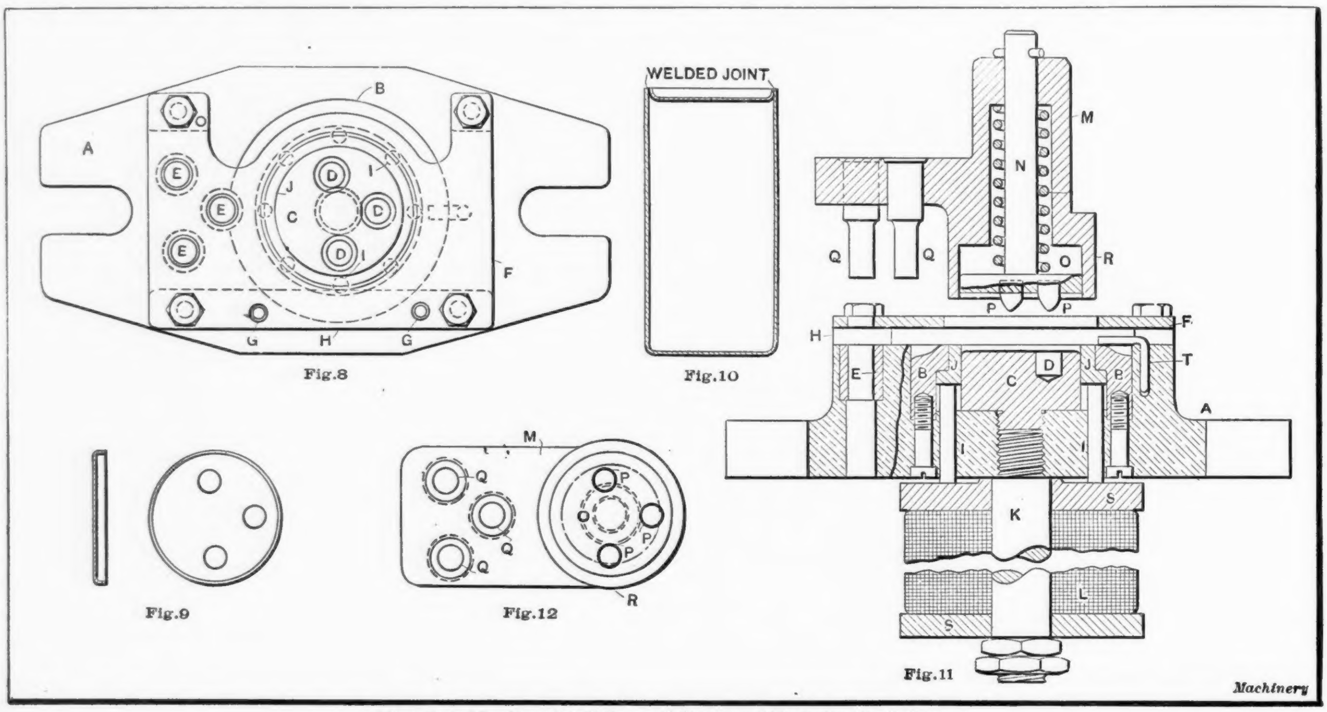
† Consulting engineer, 165 Broadway, New York City.

Fig. 8 is a plan view of the single-action combination piercing, blanking and drawing die used for producing the drawn and perforated cover shown in Fig. 9, made of the same material as that for the shell. This cover was welded into the shell as shown in Fig. 10, the whole serving as a can receptacle for parts of an electrical device. Fig. 11 is a cross-sectional view of the complete punch and die designed for the cover, and Fig. 12 is a plan of the punch. A brief description will make plain the construction and action of the tools.

In the die, Figs. 8 and 11, *A* is the cast-iron die bolster; *E* are the interchangeable piercing die bushings of Blue Chip steel; *B*, the blanking die of the same material; *C*, the drawing pad; *D*, the pilot holes for pilots *P* in punch; *F*, the stripper of cold-rolled stock; *H*, the gage plates; *G*, the gage plate and stripper locating dowels; *I*, the eight blank-holder pressure pins; *J*, the blank holder ring; *K*, the spring barrel stud; *S*, the spring barrel washers; and *L*, the rubber spring barrel. In the punch, *M* is a tool steel forging machined to the shape shown; *R* is the blanking punch; *O*, the drawing die; *N*, the ejector pad with pilots at *P*; and *Q* the three piercing punches forced into slightly tapered holes in the punch proper.

Cold-rolled strips of the proper width are used for the

stampings, the metal being fed in at *H*, Fig. 11. The end is trimmed and the three holes punched, and then the strip is moved forward against stop pin *T*. The punch descending again, pilots *P* engage the pierced holes, and before the blanking punch touches the metal, locate the strip accurately. By laying out the operations and the evolution of shape as here shown, and making the drawings so as to show clearly the operation of the tools upon the metal to be worked, the expense of designing is reduced to a minimum, the tools can be put through the shop with few "cut and try" troubles, their cost will be reasonable, and their efficiency assured.



Figs. 8 to 12. Completed Can and Cover and Tools for the Latter

* * *

In an address on "Comparison between Industrial Conditions in the United States and Europe," read before the American Society of Swedish Engineers, Mr. A. L. Valentine, superintendent of the small tool department of the Pratt & Whitney Co., Hartford, Conn., quoted some figures which show how far the United States is behind Europe in the matter of safeguarding the workers. Figures show, said Mr. Valentine, that in this country 100 men are killed every day as a result of industrial accidents. Two million in a year are injured. For 1908 very reliable figures are obtainable, and these show that there were between 30,000 and 35,000 fatal accidents that year. Of the deaths of male workers between the ages of 15 and 44, 15 per cent are due to accidental causes, and of these, at least half, or 7½ per cent, are incurred in the act of making a living. If such a proportion were lost in battle, it would be considered a disaster. Figures also show that the loss of life per thousand in the mines in the United States is greater than in France, Belgium and Great Britain combined. Manufacturers in Germany, which country has been at work preventing accidents for a quarter of a century, are compelled to be members of protective associations. These associations employ inspectors whose duty it is to inspect factories, nearly always, semi-yearly, especially those where women are employed. Seventy-five per cent of our accidents could be avoided by precaution. Better light and ventilation and better spacing of machinery should be insisted upon. It is better to build right, than to furnish safeguards after things are done wrong. Laws which this country has relating to employers' liability should at least be enforced, and those responsible would give a little more thought to the value of human life.

* * *

The aerial navy of France is assuming large proportions. Increases have been made in former appropriations and according to the latest decisions of the French war department, the French army will, during the present year, have 322 aeroplanes and 15 dirigibles at its disposal.

DRILLING AND COUNTERBORING FROM CROSS-SLIDE IN THE AUTOMATIC

By S. NEVIN BACON

Hand screw machine operations are frequently performed on work partly made in the automatic machines, because in order to complete the work in the automatic machine it would require seven tools, which it is not possible to hold in the turret of a Brown & Sharpe automatic screw machine. At *A*, in Fig. 1, is shown a piece of work knurled on one end, which was made in a No. 2 Brown & Sharpe automatic screw machine. Now unless we wish to use a combination counterbore, the list of turret tools required will be a stop, center, drill, reamer, two counterbores and a knurl.

The method used in holding the extra counterbore is shown at *A* in Fig. 2. The counterbore is held in a holder placed on the cross-slide, and when the counterbore is in line with the hole in the work it is fed forward by means of the stop in the turret coming against the rear end *a* of the counterbore. The counterbore is made a good sliding fit in the hole

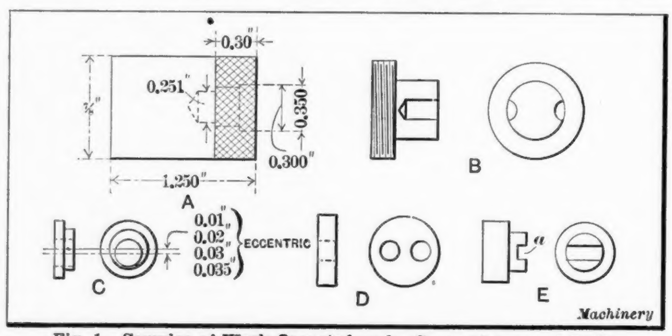


Fig. 1. Samples of Work Operated on by Counterbores and Drills held on the Cross-slide

in the boss, and is prevented from turning by the headless screw, *b*. A pin driven into the shank of the counterbore and a helical spring assist in keeping the counterbore in the "back" position. The order of operations for producing the piece shown at *A* in Fig. 1, is as follows:

Order of Operations	Revolutions	Hundredths
Clearance	19.6	2
Feed stock to stop	19.6	2
Revolve turret	19.6	2
Center, 0.125 inch rise at 0.0063 inch feed	19.6	2
Revolve turret	29.4	3
Drill, 0.500 inch rise at 0.0056 inch feed	88.2	9
Revolve turret	29.4	3
Ream, 0.500 inch rise at 0.0072 inch feed	137.2	14
Revolve turret	29.4	3
Counterbore, 0.150 inch rise at 0.0014 inch feed	107.8	11

Revolve turret	29.4	3
Knurl on, 0.300 inch rise at 0.0102 inch feed.	29.4	3
Knurl off, 0.300 inch rise at 0.0153 inch feed.	19.6	2
Revolve turret	29.4	3
Advance front slide and dwell	88.2	9
Counterbore from cross-slide, 0.125 inch rise at 0.0021 inch feed	(58.8)	(6)
Clearance	(19.6)	(2)
Cut off, 0.477 inch rise at 0.00167 inch feed..	284.2	29
Total	980.0	100

The cams for producing the piece shown at *A* in Fig. 1 are shown in Fig. 3, where the various functions of the lobes are clearly indicated. The most interesting lobe on this set of cams is the lobe on the cross-slide cam from 63 to 71,

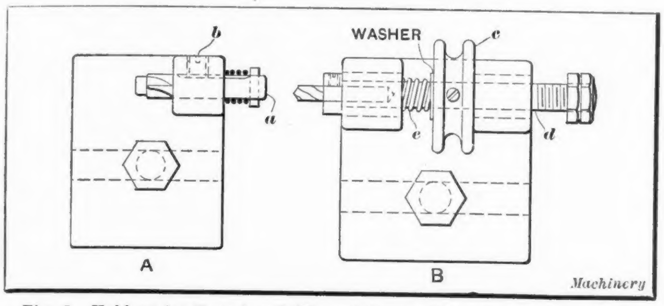


Fig. 2. Holders for Carrying Drills and Counterbores in the Cross-slide

which brings the special counterbore shown at *A* in Fig. 2 in line with the hole in the work. The stop in the turret used for feeding in this counterbore, and which is also used for gaging the stock to length is operated by the lobe from 63 to 69 on the lead cam. It will be noticed that this lobe is much lower than the lobe from 2 to 4 gaging the stock to length, the reason, of course, being that the counterbore projects much further from the chuck than does the stock when fed out.

Another simple method of holding an extra tool on the cross-slide is illustrated at *B* in Fig. 2. Here the holder is made

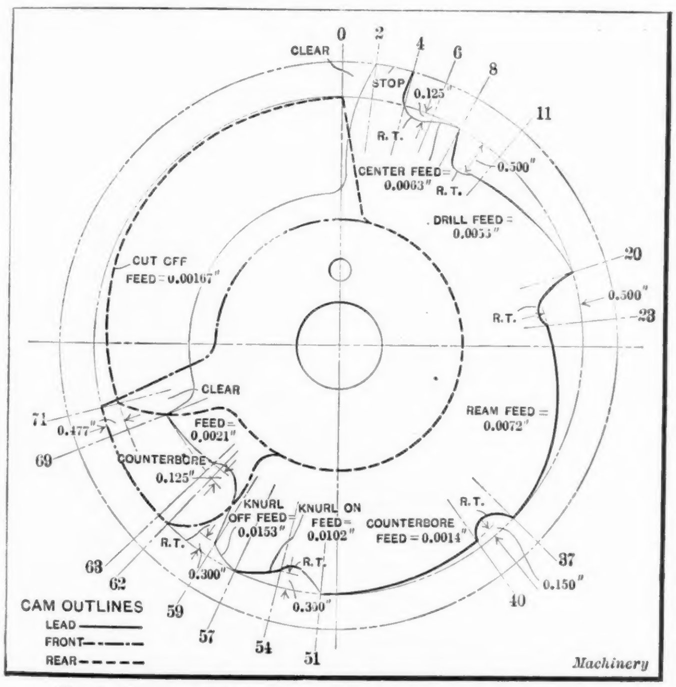


Fig. 3. Cams used in Producing the Piece shown at A in Fig. 1

so that it will take either a drill or a counterbore, as the case may be, which is held in it by means of a headless screw. The tool is rotated by means of the grooved pulley *c*, which is fastened to the spindle *d* as shown. This pulley is driven from the overhead works by a round belt, which is left sufficiently slack to allow the front cross-slide to advance to a position in line with the work. The drill is fed forward by a stop held in the turret, and is withdrawn by the coil spring *e*.

Other operations performed with drills and counterbores held on the cross-slide are shown in Fig. 1 at *B*, *C*, *D* and *E*, respectively. At *C* is shown a piece made with an eccentric hole. This is easily produced by means of a drill held in a holder fastened to the cross-slide. Of course it is necessary to lock the spindle when the hole is being drilled. A drill holder similar in construction to that shown at *B* in Fig. 2 is used. It will be noticed that the piece shown at *C* is made with holes having different degrees of eccentricity; otherwise the pieces made with an eccentric hole are of the same size and shape.

It is interesting to compare this method of drilling with the old method, which consisted in holding the stock in an eccentric chuck or in drilling each piece in a drill jig. The method last mentioned is expensive, and the eccentric chuck method is very destructive to the cut-off tools owing to the pounding of the stock against the cutting edge.

At *B* is shown how wrench slots were produced in a special nut. The holes were first drilled, after which the shank was turned down by means of a box-tool, leaving only one-half of the drilled holes in each side. To produce this piece, the cross-slide cam moves the drill and holder forward part way, then dwells while the first hole is being drilled, by means of a stop in the turret forcing the drill into the work. After the first hole is drilled, the cam advances into position for the second hole, when the same operation is repeated. At *D* is shown a washer provided with two holes which were also drilled in this manner. At *E* in Fig. 1 is shown a piece which requires a different movement. The lead cam is not used at all, and the groove *a* is cut with a reamer instead of a drill. After the machine spindle is locked in position by means of the brake, the reamer starts at one side and is fed across by the cross-slide cam operating the slide upon which the reamer is mounted. These special operations give little trouble especially on brass work, the material from which the parts described were made.

* * *

BRITISH VIEW OF BRITISH CONDITIONS

The following editorial from the *Mechanical World* gives an interesting view of some industrial conditions in Great Britain that are very different from the conditions here. That it should be considered remarkable that a firm should pay wages to its engineering apprentices, and that a business career should be considered "undignified," is strange to us, and while we have seen frequent allusions to the latter subject in stories and novels, yet we were hardly prepared to accept it as a plain fact with a practical bearing on the administration of engineering undertakings in Great Britain at the present day.

"A remarkable offer has just been made by an electrical company in order to attract into the shops and offices men of superior education and some social standing. Instead of asking a premium of three hundred pounds or more for the training of young men in electrical engineering, the company is prepared to receive a number of promising university men and make them a reasonable remuneration. The men are required for good positions and salaries in an administrative capacity later on, and it will be of some interest at some future time to learn the result of the offer. At present it is possible to obtain the best brains and experience in the world for the purely technical side of the industry on paying suitably for them, but for the administrative side the best material, we are told, is represented by the British office boy. It is strange that before making an appeal to those of university education an effort has not been made to secure suitable candidates from the technical colleges and schools; or has sufficient experience already been obtained with the material turned out by these institutions? If so, is it hoped to be more successful with university men, who have been taught to regard business as undignified or as representing a fall in the social scale? There may, however, be exceptions, and the hope may be expressed that they will be discovered, so that the experiment may be afforded a practical test."

* * *

The latest statistics relating to the exports and imports of machine tools in Germany show that the exports increased from 59,100 metric tons in 1910 to 71,500 tons in 1911. Austria-Hungary and Italy imported more German machine tools than any other country, but France and Russia also proved themselves to be good customers. The imports amounted to 7400 tons of which 4500 tons was from the United States, and 960 tons from Great Britain. The total value of the machine tools exported in 1911 was in round numbers $19,000,000, while the total value of the imports was $2,300,000.

INTERNAL GRINDING PRACTICE IN THE HARDINGE BROS. SHOP

By EDWARD K. HAMMOND*

In developing methods of internal grinding—noteworthy on account of the low speeds used to meet the most exacting specifications for accuracy and finish—Hardinge Bros., Inc., of Chicago, Ill., have approached the problem from the opposite side to that taken by most manufacturers. Instead of taking the standard products of the grinding wheel manufacturers and driving them at the excessively high speeds for which they are suited, special wheels have been obtained for the different grinding operations in the Hardinge factory. These wheels are bonded in a manner which adapts them for their work when running at speeds ranging from 4500 to 10,000 revolutions per minute.

It is a generally recognized principle of grinding that a well-defined balance exists between the grade and grain of a

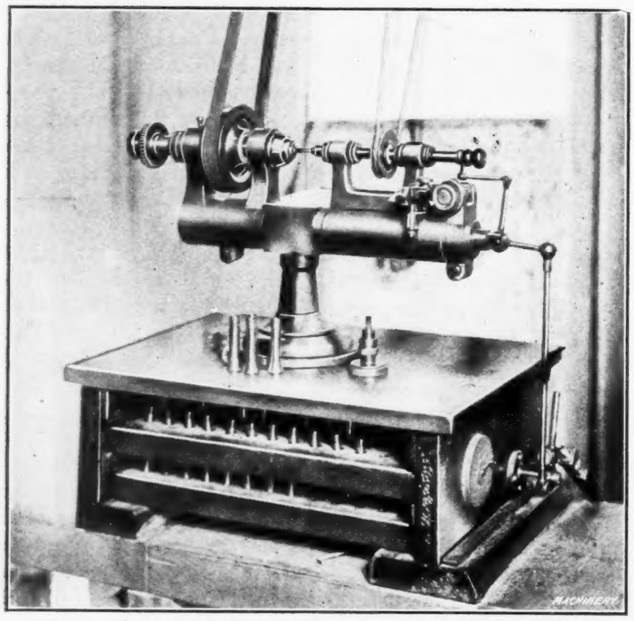


Fig. 1. Lapping a 0.125-inch Chuck at a Speed of 4500 R. P. M.

wheel and the speed which makes it suitable for a specific grinding operation. Soft wheels part readily with their abrasive material and must be driven at high speeds in order to reduce the resistance between the wheel and the work; hard wheels have the abrasive material more firmly secured in the bond, and such wheels are driven at lower speeds in order that the resistance may be great enough to break away the abrasive material and maintain a good cutting surface. This relation between the grade of a wheel and the speed which adapts it to a given grinding operation presents two courses of action in preparing the equipment. The speed of the most suitable type of standard wheel may be adjusted to enable it to handle the work, or, after deciding upon a practical range of speeds, a special wheel may be developed to work at such speeds. The latter method is, of course, limited by the possibility of producing a wheel that will give satisfactory results when operating within the selected speed range.

Grinding Wheels of Small Diameter

The general tendency in internal grinding has been to accept the standard wheels offered by the manufacturers, and, after selecting the type of wheel most nearly suited to the requirements of the work, to adjust the machine to drive the wheels at the proper speed. In grinding small holes, the wheels are necessarily limited in size, and with standard wheels, it has been necessary to adopt excessively high angular speeds. This has given rise to the assumption that it is necessary to drive small wheels at high speeds in order to give the abrasive the ability to cut, and as a result, internal grinding machines have been built along lines enabling them to run at speeds as high as 100,000 R.P.M. It cannot be denied, however, that such speeds have great disadvantages owing to the effect upon the machines, and the limited control which the mechanic has over his work when operating under such conditions.

* Address: 9620 Hoyne Ave., Chicago, Ill.

With the view of obviating these objectionable features, the Hardinge firm entered into a consultation with the Eagle Emery & Corundum Wheel Co., of Chicago, which resulted in the undertaking of experimental work with different bonding materials. These experiments showed that it was possible to produce hard wheels in which the abrasive material was held firmly enough to allow them to run at greatly reduced speeds. Further work was then carried on which resulted in the production of different types of wheels that were especially suited to the individual internal grinding operations in the Hardinge shops. The abrasive materials used were emery and corundum. Carborundum was discarded, owing to the damage caused by particles of this abrasive material getting between sliding members of the machines. In the cases of emery and corundum, this is not as serious a matter, because particles of these abrasive materials are destroyed before they have done serious damage, but if a particle of carborundum gets between two sliding parts, its extreme hardness enables it to last for a sufficient length of time to do considerable damage. In making these special wheels, the hardness was carried as far as possible, in order to provide for slow speed drives, the limit in all cases being the ability of the abrasive material to break away from the bond and thus maintain a good cutting surface on the wheel.

Grinding Practice in the Hardinge Shop

The making of the different sizes of draw-back chucks for the bench lathes manufactured by Hardinge Bros. forms one of the important classes of internal grinding operations in their shops. The internal diameters of these chucks cover a range from 0.010 inch up to 1.687 inch. Chucks ranging in size from 0.010 inch up to 3/16 inch are finished by lapping, while the larger sizes are ground with the special wheels. In finishing these chucks, they are mounted in the lathe spindle in the regular way, and the grinding attachment drives the

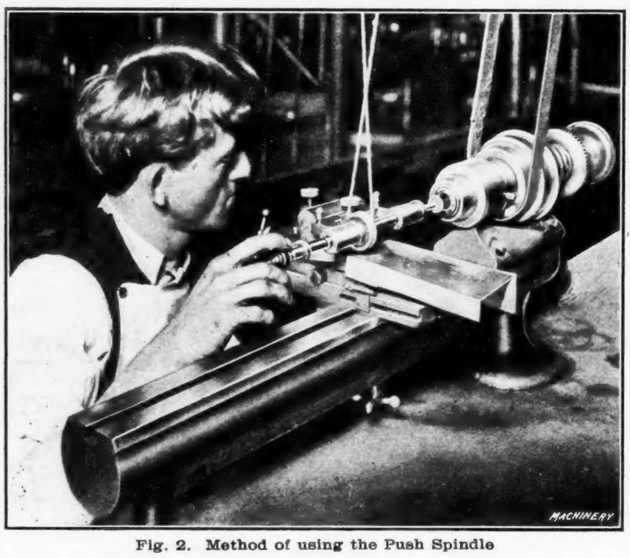


Fig. 2. Method of using the Push Spindle

wheel. Before hardening, the chucks are drilled or bored to approximately the required size, and, in the cases of the smaller sizes, which are to be finished by lapping, the holes are burred to within about 0.001 inch of the standard sizes by means of circular files.

The plugs used for the lapping operation are made of soft steel and are driven at speeds ranging from 4000 to 5000 R.P.M. Fig. 1 shows a machine equipped for the lapping operation on a chuck of 0.125 inch internal capacity. The lap is driven at 4500 R.P.M. and is moved in and out of the hole by means of the system of levers connecting the spindle with the rod at the right-hand side of the machine, which rod is given a reciprocating movement by a crank on a shaft behind the bench. The important point in securing accurate work in these lapping operations is to have the work so heat-treated that all parts are of equal hardness. If this precaution is not observed, the softer parts of the work will take up the abrasive and thus resist being cut away; the lap will also be damaged through the "back-biting" action of the abrasive imbedded in

the work. At the same time, the harder parts of the work will not take up any of the abrasive and will be ground away faster, the full action of the lap being exerted upon them.

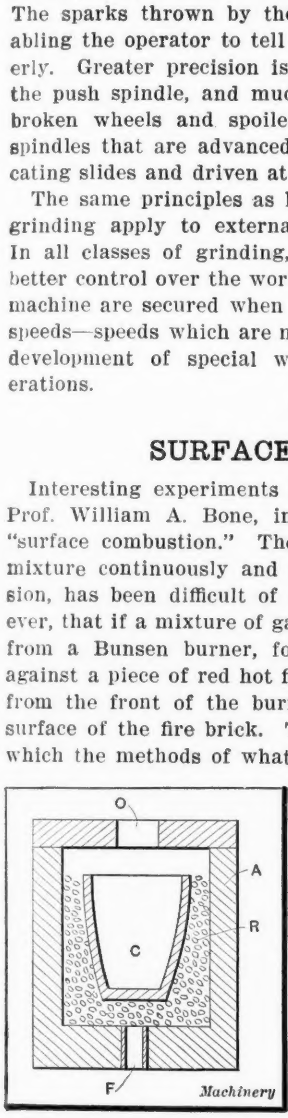
An important advantage is secured in internal grinding operations through the use of the push spindle with which the Hardinge grinders are equipped. This spindle is held by two bearings provided with dust-proof washers to prevent particles of abrasive material from damaging them, and may be advanced to the work by pushing forward the finger piece, as indicated in Fig. 2. This finger piece revolves on a bearing and is held between the thumb and index finger, as shown; the sensitive touch which the operator secures in this way enables him to tell whether he is working under proper conditions, as soon as the wheel comes into contact with the work. The sparks thrown by the wheel also act as a guide in enabling the operator to tell whether the wheel is cutting properly. Greater precision is made possible through the use of the push spindle, and much of the trouble experienced with broken wheels and spoiled work, when using the ordinary spindles that are advanced to the work by means of reciprocating slides and driven at excessively high speeds, is avoided.

The same principles as have been outlined for the internal grinding apply to external work when using small wheels. In all classes of grinding, it should be borne in mind that better control over the work and a longer life for the grinding machine are secured when operating at the lowest practicable speeds—speeds which are made possible through an intelligent development of special wheels for individual grinding operations.

* * *

SURFACE COMBUSTION

Interesting experiments have recently been carried out by Prof. William A. Bone, in connection with what is termed "surface combustion." The problem of burning an explosive mixture continuously and quietly, that is, without an explosion, has been difficult of solution. It has been noted, however, that if a mixture of gas and air, emitted at high velocity, from a Bunsen burner, for example, is permitted to strike against a piece of red hot firebrick held a short distance away from the front of the burner, the mixture will burn at the surface of the fire brick. This constitutes the principle from which the methods of what is called surface combustion have been developed. As an example of its application, the accompanying engraving is shown. A crucible C is placed in a furnace A. The crucible is completely surrounded with a highly refractory granular material R, and the gases of combustion escape at O. If the mixture of gas and air is properly adjusted, the combustion will go on quietly without a flame within the granular material, and this latter will reach a state of intense incandescence.



Arrangement for Heating Crucible by Surface Combustion

The distinguishing and essential feature of the new process is that a homogeneous explosive mixture of gas and air in the proper proportions for complete combustion, or with air in slight excess, is caused to burn without flame in contact with a granular incandescent solid, whereby a large proportion of the potential energy of the gas is immediately converted into radiant form. The advantages claimed for the new system are that the combustion is greatly accelerated by the incandescent surface, and can be concentrated just where the heat is required; the combustion is perfect with a minimum excess of air; the attainment of very high temperatures is possible; and owing to the large amount of radiant energy developed the transmission of heat to the object to be heated is very rapid.

A valuable application of the process is that of diaphragm heating. The diaphragm is a block of granular refractory material held together by a suitable binding agent, and so coarse in its structure that a gas can flow through it. This diaphragm is mounted over an empty chamber connected to the source of the combustible gaseous mixture. When the gas is turned on, it will flow through the porous diaphragm and can be ignited at its surface. It will then first burn with a flame, but as soon as the diaphragm becomes heated, the flame will gradually disappear, the combustion taking place at the surfaces of the pores of the diaphragm. Thus the diaphragm becomes a hot radiating surface, the temperature of which can be regulated by regulating the amount of gas mixture supplied.

Very high temperatures can be obtained by this method of combustion. Prof. Bone has found that in the furnace illustrated in the accompanying engraving, temperatures far above the melting point of platinum can be obtained. This method of combustion is also highly efficient. A muffle heated to a certain temperature by ordinary means was found to require 105 cubic feet of gas per hour, while the same muffle heated to the same temperature by surface combustion required only 43 cubic feet of gas per hour.

Another and perhaps the most valuable application of the process is for steam boilers. Boilers arranged for surface combustion have a mixing chamber in front of the tubes and connecting with them. The tubes contain the granular refractory material. The gas mixture is forced through the tubes at a high velocity, and complete combustion is insured after the gas has traversed a very short distance. The remainder of the granular material in the tubes acts as a baffle for the hot gases, forcing them towards the walls of the tubes in order that a large proportion of the heat may be given over to the water. A fairly large boiler has been built on this principle, equipped with 110 combustion tubes; this boiler has been successfully used in an industrial plant. While the principal idea involved is not entirely new, great advance has lately been made in its application to practical purposes.

* * *

TOO MANY PATENTS A HINDRANCE TO PROGRESS—A BRITISH VIEW

In a recent issue of the *Practical Engineer* (London) the following comments on patent protection carried too far for the best interests of progress in design, are given in an article entitled "Hindrances to Progress in Machine Tool Construction":

"Even to the student of machine tool literature and to the designer or draftsman, it is a very difficult matter to point out any one feature in most of the present-day machines which possesses self-evident novelty. Take, for example, the present-day high-speed drilling machines. What do they comprise in essence but a drill spindle mounted on ball bearings? Some arrange their ball bearings in one way and some in another. Some have one form of belt drive and some another. But the fact remains that the chief features are the same in all cases. The difficulty in which the designer finds himself when he attempts to improve upon his machine is to do so without copying exactly his rivals' productions. On many of these the ominous word 'patent' appears, whilst all that is covered is some particular disposition of ball bearings or the like, which is not the product of the inventive brain, but the outcome of the designer's needs and constructional skill. We venture to suggest that the name and position of the manufacturer are in most cases the only watch dogs that guard against encroachment, and that the patents themselves are valueless except as commercial propositions. It should be too late in the march of progress for any person to claim as his own the application of any well-known form of ball bearing to any particular machine, but the fact remains that patents are granted therefor and are a menace to progress.

"We have no hesitation in saying that the granting of patents for the slightest constructional differences, amounting sometimes to the proverbial substitution of a screw for a bolt, is becoming a hindrance to progress and a matter which will require to be dealt with."

* * *

The problem of casehardening gear teeth without distortion has been solved by the Cadillac Motor Car Co., Detroit, Mich., by copper-plating the gears all over before taking a finishing cut on the teeth. The finishing cut removes the copper plate from the tooth faces and flanks and when casehardened these parts only are hardened, the carbonizing effect of the pack being prevented on the other parts of the gear by the copper plate. The practical result is casehardened teeth with so little distortion of the gear as a whole that it can be corrected to practically perfect accuracy by means well known to gear makers.

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DOUBLE-CUTTING PLANERS

Many attempts have been made to design a planer that will cut with equal efficiency on both the forward and return strokes. Recently a planer was brought out in Great Britain which is claimed to possess certain advantages in this respect; but while it is evident that the elimination of the idle strokes means a considerable advance in efficiency, the great difficulty to be overcome is to design a planer which will cut in both directions with equal efficiency and accuracy. It is apparent that the planer, as made today, is designed to take a maximum cut in one direction only, and a radical change must be made in its design before a really satisfactory machine can be produced which will take heavy cuts in both directions. The tool-head is clamped to the face of the cross-rail, which, in turn, is clamped to the face of the housings, and the stresses produced in these parts when a cut is taken in one direction are quite different from those when the cut is taken in the other direction. In one case there is a tendency to compress all of these parts solidly, giving a firm support to the cutting tool; in the other the tendency is to pull all joints apart, thus depriving the cutting tool of the firmness of its support and creating a tendency to chatter. It appears that if planers are to be made double-cutting, the successful design must be arranged on lines quite different from those of present planers, so that equal support is given to the tool when cutting in both directions.

* * *

PANTOGRAPH PRINCIPLE IN INTERCHANGEABLE MANUFACTURING

When a new machine is developed consisting of many small parts which must be accurately shaped and cheaply produced, preparation for manufacturing ordinarily involves heavy expenditures for presses, punches, dies, jigs, reamers, boring cutters and other tools common to interchangeable manufacturing. When the future of the machine is reasonably sure, there can be no question as to the wisdom of providing the best and most efficient tools that skilled designers and toolmakers produce; but when the outcome of the venture is in doubt because of the practical impossibility of testing the commercial conditions in any other way than by putting the machines on the market, the problem may be sorely perplexing.

Generally, it will not do to put out handmade machines, as the slowness of production, inevitable inaccuracies and high cost make that procedure impracticable. The common practice in that event is to make expensive form milling cutters, dies and jigs for producing the vital parts and to make the auxiliary parts by hand and by ordinary machine tools.

The possibilities of the profiling machine in manufacturing parts of considerable size which do not require the highest accuracy of form have been known and widely applied for many years, but the pantograph principle applied to profilers, of which certain engraving machines are good examples, has not in our opinion been developed as much as its merits deserve.

Take the case of an adding machine which has been developed in the handmade form to a practical success. The matter of making parts from flat stock in hundred lots with pantograph profilers would consist first of making the "copy," say, five times scale, correcting errors by trial, and then actually producing the parts from flat stock cut into strips and held for the operations by suitable quick-action chucks. The pantograph profiler, unlike the form milling cutter on the Lincoln milling machine, is not confined to the production of contours from flat stock only, but can be designed to work in three directions, thus becoming universal in scope. If heavily designed, these machines could be made to function automatically, and produce work of widely varying forms at costs higher than punch and die work, it is true, but so low that the product could probably be placed on the market advantageously under the conditions set forth in the beginning.

* * *

APPRENTICES TEACHING APPRENTICES

In shops employing numbers of apprentices directly subject to the foreman, the common plan of instruction on the operation of machines is to delegate the boy about to give up a machine to instruct the next apprentice in its construction and operation. This method has the advantage of relieving the foreman of the duty of instructing the boys in machine operation—for which he usually has little time and which, in many cases, he could not effectually carry out—and of making each boy as he "graduates," review his knowledge by showing his successor how and what to do. This method also has disadvantages of a serious nature. Not many boys are capable of running a machine at its highest productive capacity, and they are not expected to. They are likely to gradually sink in the scale of efficiency through lack of comprehension or competent instruction until a very low state is reached. Not only may the functions of a machine be but partly understood and used, but improper instruction in oiling bearings and caring for tools, belts, etc., may lead to rapid deterioration of the machine and its product.

When the foreman wakes up to the situation, there is a grand "raking over the coals" and "jacking up all around." Boys genuinely ignorant of their duties are blamed, perhaps, for what they could hardly be expected to know, and the result is dissatisfaction all around. The foreman thinks that apprentices are nuisances generally, and the boys are sorry they started to learn the trade. Unfortunately, few foremen are qualified to act as apprentice instructors. If they are good foremen they are likely to be poor teachers, and, *vice versa*, good teachers are likely to be indifferent foremen. The ability to impart knowledge is a rare gift, fully developed only after years of training.

Conditions like those set forth are less likely to develop when the boys are in charge of an overseer who devotes himself exclusively to their instruction and to instilling those ideals which are necessary for the making of good mechanics. The plan of letting a boy instruct his successor may then work out; that is, when the boy acting as teacher has had careful training and is able to produce good work in reasonable time, and to take proper care of his machine. But unless he has been and is under competent supervision it is likely to lead to inbreeding of vicious methods and principles.

HELPING A MAN TO FIND HIS PLACE

One of the valuable features of the new systems of management, generally known as "scientific," is that when properly conducted they aid the individual in finding that place in an organization where he can do his best work, receive the most compensation, and in general develop his latent powers so as to produce the greatest benefit to himself and his employer.

In factories organized on the task basis it is often found, for example, that a man working on a lathe cannot possibly fulfil the task that has been found to be easy for the average man. In such a case, this man is not kept at his machine, but is shifted around to other machines or work better suited to his capacity. In nearly all instances, a certain machine or work can be found in the shop whereon this man will be able to perform the set task with ease.

Under the old methods of management such a man would have been retained year after year at work for which he was not fitted. He would have been poorly paid, and at that would have been a poor investment for his employer. He would have been dissatisfied, and helpless to better his condition. Under the new system he finds his proper place, earns good wages, is satisfied and returns a much greater profit to his employer. Of course, all so-called scientifically-managed shops have not applied this important principle of management, and to the extent that they have not they have been unsuccessful with the new methods.

Scientific management is not a mere stop-watch system; it requires constant and intelligent attention. It is not a system which once installed will run itself, nor is it a system that can be run successfully by a man whose views on the relation between employe and employer are too narrow. Scientific management is a broad scheme with far-reaching purposes, and it requires a broad-gage man to handle it.

* * *

CASEHARDENING PROCESSES AND RESULTS

The common process of treating wrought iron with a carbonaceous compound to give it surface hardness is probably the oldest method employed to convert iron into steel. The surface hardness of "case" results from the infusion of carbon which penetrates the iron to depths depending on the nature of the pack and the time of heating. The converted iron (steel) hardens when heated and quenched in cold water. The ease and cheapness of the process by which common iron can be changed to steel of considerable endurance has made possible the use of the casehardening process for a multitude of purposes requiring a cheap, strong, and tough material with hardened surface. Fifty years ago, before the advent of Bessemer steel, some of the railway companies in England treated wrought-iron rails to harden the rail heads and thus increase their durability. The later development of the iron-clad and armored battleship led to the development of casehardening processes for steel armor plate of extraordinary efficiency, producing extreme hardness to a depth of several inches and leaving the remainder of the plate soft and very tough.

In machine shops the casehardening process has been used to some advantage in the making of tools, especially large milling cutters, taps, etc. Varied success has attended these efforts, and hardly any two men having experience in different shops will agree on the value of such products. One shop may obtain uniformly satisfactory work, when another can never be sure of the quality of casehardening work produced.

The reasons for these varied results are several, the chief, of course, being the nature of the pack and heat treatment. One common error is to quench the work in the bath as it is dumped out of the boxes. For all work requiring the best quality of casehardening the treated parts should be allowed to cool slowly when dumped, and then heated to the hardening temperature so as to harden on a "rising heat."

But with the best packing materials and approved heat treatment, the product will vary, and sometimes be unsatisfactory if the chemical composition of the mild steel commonly used includes impurities known to be deleterious to tool steel. Sulphur, manganese and phosphorus must be present in minimum percentages only, if the casehardened product is to have those qualities which give it reliability and durability. The salesman who offers a casehardening compound with the claim that qualities will be produced in the product which make it equal to tool steel, is not honest and sincere if he does not state that the steel used must have certain specified chemical components to start with. Another fact which should be kept in mind by the user of casehardening compounds is that the difference in cost of mild steel and tool steel is materially reduced by the cost of the compounds and the heat treatment. Not infrequently the saving may be reduced to a negligible amount.

* * *

THE MOVING PICTURE AS AN AID TO MECHANICAL INSTRUCTION*

By CHESTER L. LUCAS†

A few weeks ago, at one of the popular moving picture theatres in New York City, a film was shown to illustrate the way in which "photo-plays" are originated. Among other views, were several intended to convey an idea of the work incident to the making of the moving picture machine itself. One of these mechanical views showed the drilling of the frames of the machines, and as it was a close-range view of the work and table of the drilling machine, every detail of the operation being performed could be plainly observed. The drill could be seen entering the bushing of the jig; chips curled out from the drill with credit to the man who sharpened it, and the drill "broke through" in the most natural manner possible. Any mechanic in the audience must have felt a responsive thrill as he viewed that part of the film. Another view showed the making of the film-spool on an automatic turret lathe. The bar stock could be seen as it was fed forward; the turning tools and turret came up to the work just as a few hours before they might have been seen to do in many shops; the drills and forming tools could be plainly seen, and even the cutting-off tool was visible as it fed slowly into the work. There were several other views of a like nature, the whole comprising a most graphic illustration of some of the phases of machine shop practice.

There seems to be every reason to believe that the moving picture should be of great value in imparting mechanical instruction. While the operations shown in this case were necessarily elementary, in order to appeal to the general public, there should be no trouble in making films that would show the working of complex mechanism. If the mechanism was very small, it could easily be enlarged in showing the film, and therefore be even more clearly grasped than from observing the work itself. Again, if the parts moved with great rapidity, as in adding machine mechanism, the film could be "slowed down" until the operation was easily understood. With the addition of a lecturer, to explain difficult parts of the operations shown, such exhibitions would be highly instructive to apprentice, mechanic or engineer.

Undoubtedly the greatest stumbling-block in the path of this method of instruction at the present time is the cost of the film. It is said that the average film costs about one thousand dollars to produce, and except for the fact that each new film is copied from twelve to fifty times, there would be little profit in making films. In the case of films for illustrating mechanical operations, correct shop practice and similar subjects, no expensive company of actors would be required, which, of course, would lessen the expense of making the film.

Within a few years' time a moving picture machine will undoubtedly be just as necessary a part of the equipment of a college as a microscope is to-day. It would even now seem feasible for a large number of trade schools or educational classes to confer as to what phases of their work could best be illustrated and taught in this way, after which several films could be made, distributing the expense. These films, together with a machine for showing them, could be sent from one school to another for exhibition; thus all would derive full benefit at a minimum cost.

* For previous suggestions and comments on this subject, see "Moving Pictures as an Aid to Teaching Trades," January, 1909; "Moving Picture Show as an Educator," page 527, engineering edition, March, 1909; and "Moving Picture Shows as an Incentive to Crime," page 604, engineering edition, April, 1909.

† Associate Editor of MACHINERY.

NOTES AND COMMENT

Monel metal, which has been termed a "natural" alloy, is regarded as a successful substitute for steel and bronze in steamship propellers. It has recently been cast in pieces weighing as much as 25,000 pounds. Several castings for propellers have been furnished to the United States government.

The question of standard colors for piping systems has been taken up by several German engineering societies, and the following color scheme has been agreed upon: Green is to indicate water; yellow, gas; blue, air; white, steam; black, tar; pink, lyes; pink with a red ring, acid; brown, oils; and grey, vacuum. A black ring or band indicates impurity; a red ring, danger; thus a green pipe with a black ring carries refuse water; a white pipe with a red ring carries superheated steam, etc.

The trackless trolley systems which, during the past year, have been inaugurated in a number of places in Europe, appear to have a considerable future on account of the very decided saving in the initial investment. As an illustration it may be mentioned that Mr. H. Jackson, in presenting a paper before the Birmingham branch of the Institute of Civil Engineers, showed that routes of trolley systems 27 miles long, in the suburbs of Birmingham, could be established complete for a service of fifteen minutes intervals for about $375,000, while the same system along the conventional electric trolley line construction would cost about $1,650,000.

It appears from a recent Blue Book published by the British government, that the United States is practically the only country of any consequence in which there is no law for the compulsory working of patents. All other industrial countries have enacted laws—some long ago—which require the patentee to manufacture the patented article within a certain number of years, or to license somebody else to manufacture it. If the patented article is not manufactured to what is termed "an adequate extent" within the specified number of years, the patent becomes invalid. Great Britain makes this time four years, but most other nations do not permit so long a period before the patent must be actually exploited.

It is stated in the *Brass World* by Roy C. Davidson of Fort Blackmore, Va., that copper may be welded in the following manner: The pieces to be welded are placed in a fire and heated to a black heat, after which they are coated with borax. The two pieces are then removed and hammered. They are again returned to the fire and this process is repeated twice, after which the joint is covered with ferrous sulphate. The pieces are now placed in the fire again and heated as hot as the copper will stand without melting, and the joint hammered together. It will be found, it is stated, that a sound and homogeneous joint will then result.

According to *Engineering*, copper deposits of great importance have been found in the Katanga district in Congo, between the Zambesi and Congo rivers. It has been estimated that the Katanga district has copper deposits of sufficient extent to fill the world's demand for copper for the next hundred years. Besides the copper deposits, gold, platinum, silver and zinc are abundantly found in this district. While the enormous mineral wealth of this province has been a matter of knowledge in financial circles for some time, comparatively little has as yet been done with relation to mining enterprises, on account of the great transportation difficulties presented.

The import of machine tools to Great Britain is steadily increasing, and some concern is felt by the British mechanical journals on this account. It is stated that the import of machine tools in 1911 was three times that in 1910, and over two and one-half times that in 1909. On the other hand the export of machine tools from Great Britain in 1911 was less in tonnage, although greater in value, than in 1910, and considerably less than the export in 1909. The Machine Tool Association formed during the past year has now a membership of eighty firms and it is expected that the activities of this organization will make it possible to place the British machine tool building business on a more satisfactory basis.

Dr. J. W. Richards, in a recent lecture before the Engineers' Society of Western Pennsylvania, gave a review of the progress made in Sweden during the past year in the production of iron and steel by electrical processes. Dr. Richards has visited Sweden every summer for several years, and is well informed on the research and experimental work done by the Swedish Iron and Steel Institute (Jernkontoret), at Trollhättan. He asserted that there was no longer any doubt but that, under the latest Swedish practice, pig iron smelted from ore in the electric furnace will shortly displace the old charcoal iron that has made the Swedish iron industry famous. In fact, some steel makers maintain that the electrically smelted iron is superior to the charcoal iron.

To find the melting points of metals which fuse only at the very highest temperatures has been found to be extremely difficult, and until recently experiments have given widely varying results. By means of electric vacuum furnaces, however, some experiments giving accurate results have been undertaken in Germany by Otto Goecke, who places the melting points of the following metals as below:

Gold	1960 degrees F.
Manganese	2277 degrees F.
Chromium	2757 degrees F.
Platinum	3182 degrees F.
Iridium	4035 degrees F.
Vanadium Carbide (Va_4C_3)	4982 degrees F.

It is stated in the *Mechanical World* that the crankshaft for a 50-horsepower engine for a certain British type of aeroplane weighs only eighteen pounds. It consists of a tubular shell made of chrome-vanadium steel, the shell being 1/8-inch in thickness. It is stated that in the tests it has proved to have a margin of safety of 38 per cent over that necessary for the 50-horsepower engine. It would seem that the aviator runs a decided risk in employing an engine where the factor of safety of one of the most vital parts is as small as this. The frightful toll paid by the lives of aviators, it seems, could be diminished to a considerable extent if such perils were avoided as are introduced by employing machinery which is worked so near the danger limit.

A mechanic, in the *Mechanical World*, calls attention to the fact that there seems to be no standard for the squares or flats on taps and reamers. He states that many firms reduce the shanks too much, and in this way not only weaken the tap or reamer, but also produce a square which is not of a standard size. Some firms make the squares with sharp corners, while others merely mill four flats, so that the end of the tap looks more like an octagon than anything else. Standardization of this detail, though of comparative unimportance, is no doubt well worth while. If taps and reamers were made with squares of standard sizes, they would be more durable, the wrenches would last longer and their number would be reduced considerably.

The first locomotive in America, built for the Camden & Amboy Railroad in 1831, is still intact in the National Museum at Washington. It is interesting to make a comparison between this engine and the locomotive recently adopted by the Pennsylvania Railroad for its heavy passenger service. The weight of the old locomotive mentioned—called "John Bull"—is 24,625 pounds, while the Pennsylvania engine with tender weighs 430,000 pounds. The two driving wheels of "John Bull" are 54 inches in diameter, while the six driving wheels of the modern engine are 80 inches in diameter. The tubes of the "John Bull" are 7½ feet long and the tube heating-surface, 213 square feet. In the modern engine, the tubes are nearly 21 feet long, and the heating surface is 4420 square feet.

THE DESIGN OF CONICAL HELICAL SPRINGS*†

By E. R. MORRISON‡

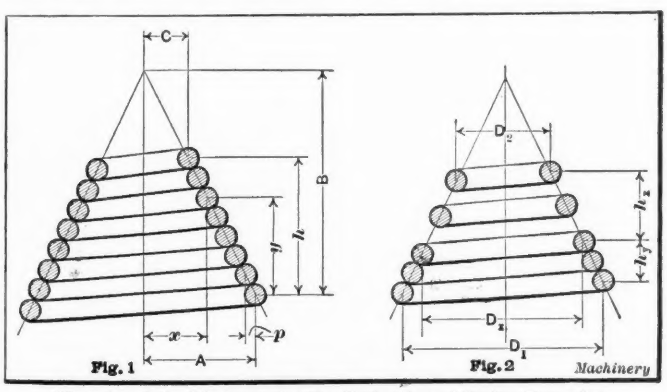
On account of their physical characteristics, conical helical springs divide themselves into two distinct classes, according to their use. The formulas applicable to a spring of this type used as a compression spring are not at all applicable if the spring is to be used as an extension spring. This is more obvious if we note that the safe load which an extension spring will carry is governed by the capacity of the largest or weakest coil, which condition is reversed in the compression state, where the spring retains its flexibility until the load becomes great enough to close up the smallest or strongest coil. It is the object of this article to develop the formulas applicable to the various types of conical helical springs. Round bar coils only will be considered.

Notation—Dimensions in Inches, Weights in Pounds

S = stress,
G = modulus of torsional elasticity,
f = deflection,
f_x = deflection under load P_x
H = free height,
h = solid height, assumed to equal $d \times N$,
y = solid height at any convenient coil,
P = capacity of spring,
P_x = any load not exceeding P,
P_1 = capacity of largest coil,
P_2 = capacity of smallest coil,
D_1 = mean diameter of largest coil,
D_2 = mean diameter of smallest coil,
d = diameter of bar from which coil is made,
A = mean radius of largest coil,
B = apex height of cone,
C = mean radius of smallest coil,
N = number of coils,
p = average horizontal pitch of coils,
w = weight of one cubic inch of steel,
l = length of bar in spring,
W = weight of spring,
x = mean radius of any convenient coil.

Deflection and Capacity of Extension Spring

It is obvious that P_x in this case must be understood to be not greater than the capacity of the weakest coil, inasmuch as a greater value of P_x would distort the spring beyond the realm of rational formulas. A conical spring is composed of an infinite number of elementary cylindrical coils, each element being in itself a uniform diameter helical spring, and each element differing from its neighbor in the one respect that each successive element has a mean diameter infinitesimally less than its first neighbor, and likewise infinitesimally greater than its neighbor on the other side. These increments of change in the mean diameter result in corresponding increments of change in the deflection of the successive elements, and being all governed by the one general expression for deflection of cylindrical helical springs, may be added together by resorting to calculus. Since the increments of change in the mean diameter are in this case in proportion to the increments of change in the solid height, it follows that the increments of change in the deflection also follow those of the solid height, and that we may expect to arrive at the summation of the deflection through a summation of the increments of change in the varying solid height, which for successive elementary cylindrical coils increases from 0 to its maximum h.



Figs. 1 and 2. Diagrams for the Derivation of Spring Formulas

Now the expression for deflection in cylindrical coil springs is:

$$f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h$$

and for capacity:

$$P = \frac{\pi S d^3}{8D}$$

The value of D is here, however, the variable, represented by $2x$. Therefore, in each elementary cylinder:

$$\frac{f_x}{f} = \frac{P_x}{P}, \text{ or } f_x = \frac{8P_x(2x)^3 h}{G d^5} = \frac{64 P_x x^3 h}{G d^5}$$

Further,

$$\delta f_x = \frac{64 P_x}{G d^5} x^3 \delta y$$

$$f_x = \int_0^h \frac{64 P_x}{G d^5} x^3 \delta y = \frac{64 P_x}{G d^5}\int_0^h x^3 \delta y.$$

But, as shown in Fig. 1, $\dfrac{B}{y} = \dfrac{A}{A-x}$; whence $x = A - \dfrac{Ay}{B}$

$$\text{Hence } x^3 = A^3\left(1 - \frac{3y}{B} + \frac{3y^2}{B^2} - \frac{y^3}{B^3}\right)$$

Hence,

$$f_x = \frac{64 P_x A^3}{G d^5}\int_0^h\left(1 - \frac{3y}{B} + \frac{3y^2}{B^2} - \frac{y^3}{B^3}\right)\delta y$$

$$f_x = \frac{64 P_x A^3}{G d^5}\left(h - \frac{3h^2}{2B} + \frac{h^3}{B^2} - \frac{h^4}{4B^3}\right)$$

Also, from Fig. 1, we have: $B = \dfrac{Ah}{A-C}$, whence:

$$f_x = \frac{64 P_x A^3}{G d^5}\left(h - \frac{3h^2(A-C)}{2Ah} + \frac{h^3(A-C)^2}{A^2h^2} - \frac{h^4(A-C)^3}{4A^3h^3}\right)$$

But $A = \dfrac{D_1}{2}$ and $C = \dfrac{D_2}{2}$. Hence,

$$f_x = \frac{8P_x D_1^3 h}{G d^5}\left(1 - \frac{3(D_1-D_2)}{2D_1} + \frac{(D_1-D_2)^2}{D_1^2} - \frac{(D_1-D_2)^3}{4D_1^3}\right)$$

$$= \frac{8P_x D_1^3 h}{G d^5}\left(\frac{D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3}{4D_1^3}\right)$$

$$= \frac{2P_x h}{G d^5}(D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3) = \frac{2P_x h(D_1^4 - D_2^4)}{G d^5 (D_1 - D_2)}$$

$$= \frac{P_x(D_1^4 - D_2^4)}{G d^4 \dfrac{(D_1-D_2)d}{2h}}$$

Observe now that the expression in the denominator is the average horizontal pitch p (see Fig. 1) of the coils:

$$p = \frac{\dfrac{D_1 - D_2}{2}}{N}; \text{ but } N = \frac{h}{d}; \text{ hence, } p = \frac{(D_1-D_2)d}{2h}$$

Therefore,

$$f_x = \frac{P_x(D_1^4 - D_2^4)}{G p d^4}$$

This then is the formula for the deflection of any extension type conical helical spring under load P_x, the value P_x not exceeding the capacity of the weakest coil, equivalent to the

* With Data Sheet Supplement.
† See MACHINERY, March, 1911, "The Design of Grouped Helical Springs," and other articles there referred to; January, 1910, "The Design of Automobile Springs," and other articles there referred to; and also MACHINERY's Reference Book No. 58: "Helical and Elliptic Springs."
‡ Address: Sharon, Pa.

capacity of a cylindrical helical spring of a mean diameter equal to D_1 and bar diameter equal to d.

If the value of P_x equals the capacity P of this spring, we have:

$$P = P_x = \frac{\pi S d^3}{8 D_1}$$

Substituting this value of P_x, we have the total deflection:

$$f = \frac{\pi S (D_1^4 - D_2^4)}{8 G p d D_1}$$

which is the final formula for the total deflection of the extension conical helical spring.

It will be noticed that the previous discussion is based on the assumption that the solid height of the spring is equal to the diameter of the bar times the number of coils in the conical spring. However, as one coil seats within the other, the solid height is really less than that assumed; the solid height becomes less as the taper of the coil becomes greater, until for a true spiral spring the solid height is reduced to the diameter of the bar. The actual deflection is dependent on the "slant height" of the conical coil which is equal to $d \times N$, as assumed for the solid height, rather than upon the actual vertical height. Due to this assumption, the changing of the angle of the cone formed by the spring does not change the actual deflection so long as the value of the slant height itself is not changed. Inasmuch as the above discussion is based on the slant height, the actual solid height of the spring and also the free height of the spring should be corrected by deducting from the value of these heights the difference between the slant height and the solid height. Stated briefly, the assumption that the solid height is equal to $d \times N$ is necessary in order to obtain the correct value of the deflection; but after this deflection has been obtained, correction should be made for this assumption.

Deflection and Capacity of Compression Spring

The deflection of a compression spring of this type is a fundamental problem of the same type. In this case, however, the summation is not the summation of increments of deflection under a uniform load and varying stresses, but the summation of increments of deflection when each elementary spring is stressed to a maximum, and hence under uniform stress.

In this case $f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h$, becomes $f = \frac{\pi S}{G}\left(\frac{2x}{d}\right) h$

$$\delta f = \frac{\pi S}{G}\left(\frac{2x}{d}\right)^2 \delta y \text{ and } f = \int_0^h \frac{\pi S}{G}\left(\frac{2x}{d}\right)^2 \delta y$$

But $x = A - \frac{A y}{B}$. Hence:

$$f = \frac{4 \pi S A^2}{G d^2}\int_0^h \left(1 - \frac{2y}{B} + \frac{y^2}{B^2}\right)\delta y$$

$$= \frac{4 \pi S A^2}{G d^2}\left(h - \frac{h^2}{B} + \frac{h^3}{3 B^2}\right)$$

But $B = \frac{A h}{A - C}$, and $A = \frac{D_1}{2}$, and $C = \frac{D_2}{2}$. Hence the expression above can be transformed to:

$$f = \frac{\pi S h}{3 G d^2}(D_1^2 + D_1 D_2 + D_2^2)$$

$$f = \frac{\pi S h (D_1^3 - D_2^3)}{3 G d^2 (D_1 - D_2)}, \text{ and since } p = \frac{(D_1 - D_2) d}{2 h}$$

$$f = \frac{\pi S (D_1^3 - D_2^3)}{6 G p d}$$

which expresses the total compression for a conical helical compression spring.

The capacity, solid, equals that of the smallest coil, or:

$$P = \frac{\pi S d^3}{8 D_2}$$

Deflection of Compression Spring for Given Loads

If the given load is less than P_1, the entire spring remains flexible, and the formula for deflection is the same as that derived for an extension spring, the condition of varying stress still being present.

If, however, the load exceeds P_1, then a portion of the spring will become solid. The division point may be found, for $P_x = \frac{\pi S d^3}{8 D_x}$, and since the load in cylindrical coils varies inversely as D:

$$\frac{D_x}{D_2} = \frac{P_2}{P_x}, \text{ whence } D_x = \frac{D_2 P_2}{P_x}$$

The deflection of the two portions of the spring should now be considered separately and added, using the two final formulas just developed.

Fig. 2 shows a graphical illustration of the divided spring. Let p_x be the average horizontal pitch of the unclosed portion, above D_x. Let p_y be the average horizontal pitch of the solid portion, below D_x.

The total deflection is then:

$$f = \frac{\pi S (D_1^3 - D_x^3)}{6 G d p_y} + \frac{\pi S (D_x^4 - D_2^4)}{8 G d D_x p_x}$$

In Fig. 2, h_y is the height, solid, of the solid portion of the spring. Its value is derived thus:

$$\frac{h_y}{h} = \frac{D_1 - D_x}{D_1 - D_2}, \text{ whence } h_y = h\frac{D_1 - D_x}{D_1 - D_2}$$

Bar Length for Conical Spring

Fundamentally, $l = \pi\left(\frac{D}{d}\right) h$, so that we have in a conical spring

$$l = \delta \pi \left(\frac{2x}{d}\right)\delta y, \text{ or}$$

$$l = \frac{2\pi}{d}\int_0^h x\,\delta y = \frac{2 A \pi}{d}\int_0^h \left(1 - \frac{y}{B}\right)\delta y = \frac{2 A \pi}{d}\left(h - \frac{h^2}{2B}\right)$$

And since $B = \frac{A h}{A - C}$, and $A = \frac{D_1}{2}$, and $C = \frac{D_2}{2}$, we get:

$$l = \frac{\pi h}{d}\left(\frac{D_1 + D_2}{2}\right)$$

Weight of Conical Spring

Fundamentally, $W = \frac{l \pi d^2 w}{4}$. Hence

$$W = \frac{\pi^2 d h w}{8}(D_1 + D_2)$$

Summary of Formulas

Summarizing and substituting for S a value of 80,000 pounds per square inch, and for G a value of 12,600,000 we have:

Extension Conical Spring Formulas

$$f = 0.002493\frac{D_1^4 - D_2^4}{p d D_1}$$

$$P = 31,416\frac{d^3}{D_1}$$

Compression Conical Spring Formulas

$$f = 0.003324\frac{D_1^3 - D_2^3}{p d}$$

$$P = 31,416\frac{d^3}{D_2}$$

Weight in each case, $W = 0.35\, dh\, (D_1 + D_2)$.

Bar length in each case, $l = 1.571\frac{h}{d}(D_1 + D_2)$

Numerical Examples

Example: Compression spring, $D_1 = 4$ 9/16 inches; $D_2 =$ 3 9/16 inches; $d =$ 1 1/16 inch; $h =$ 7 1/16 inches.

Then $N = \dfrac{h}{d} = 6.65$; $\dfrac{D_1 - D_2}{2} = 0.5$; $p = \dfrac{D_1 - D_2}{2N} = 0.075$.

$$f = 0.003324 \frac{(4\tfrac{9}{16})^3 - (3\tfrac{9}{16})^3}{0.075 \times 1\tfrac{1}{16}} = 2\tfrac{1}{16} \text{ approximately.}$$

See the accompanying Data Sheet Supplement for table of cubes, and also for other powers of numbers required in conical spring calculations.

$$H = 7\ 1/16 + 2\ 1/16 = 9\ 1/8 \text{ inches.}$$

Example: Same spring in extension.

$$f = 0.002493 \frac{(4\tfrac{9}{16})^4 - (3\tfrac{9}{16})^4}{0.075 \times 1\tfrac{1}{16} \times 4\tfrac{9}{16}} = 1\tfrac{7}{8} \text{ approximately.}$$

$$H \text{ (extended height)} = 7\tfrac{1}{16} + 1\tfrac{7}{8} = 8\tfrac{15}{16} \text{ inches.}$$

As might have been expected, the free height for the compression type is greater than the possible extended length for the extension type. This is because sufficient load to fully stress the smaller or stronger coils cannot be applied without distorting the extension spring, whereas the coils may all be stressed to maximum stress in the compression type, the closing of the coils solidly together protecting the spring from over-stress.

Reversion to Cylindrical Helical Springs

It will be noted that in each of our final formulas we have introduced the factor $(D_1 - D_2)$ and the value of $p = \left(\dfrac{D_1 - D_2}{2h}\right) d$. This has been done to leave the formulas in as simple a form as possible. Note, however, that if D_1 and D_2 each be taken as equal to D_1 or to each other, the formulas in each case revert to the fundamental cylindrical helical spring formulas, as should be expected.

Substituting $D_1 = D_2 = D$ in the extension formula

$$f_x = \frac{2 P_x h}{G d^5} (D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3), \text{ we have}$$

$$f_x = \frac{8 P_x D^3 h}{G d^5}$$

This is the fundamental formula for the deflection of an extension helical cylindrical spring under any load P_x, derived directly from the formula for load:

$$P = \frac{\pi S d^3}{8 D}$$

in which S has been replaced by its value in the formula

$$f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h \text{ giving } P = \frac{G f d^5}{8 h D^3}$$

from which $f = \dfrac{8 P D^3}{G d^5} h$

Substitute, again, $D_1 = D_2 = D$ in the compression formula:

$$f = \frac{\pi S h}{3 G d^2} (D_1^2 + D_1 D_2 + D_2^2), \text{ and we have}$$

$$f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h$$

the fundamental formula for the deflection of a compression helical cylindrical spring.

The reason for this comparison between the formulas for cylindrical helical springs and conical springs, is particularly, to bring out the fact that, while each of the conical formulas are thus shown to revert to the same form when $D_1 = D_2$, yet the conical spring formulas themselves, for extension and compression springs, are different. As already mentioned, one is an expression for deflection under a given load, regardless of stress, while the other is the expression for deflection under a uniform maximum stress. The former condition is that of the conical extension spring, while the latter is that of the compression type.

Auxiliary Formulas

The expressions for deflection and capacity are the main formulas for all helical springs; from these are developed such other formulas as may be desired. In this particular case, care must be taken in making such further developments, if using the expressions $D_1^4 - D_2^4$ and $D_1^3 - D_2^3$, to note that resulting formulas will not revert to simple cylindrical helical formulas, because of the fact that a zero quantity has been introduced when D_1 becomes equal to D_2.

Therefore, further formulas are based on the longer but primary formulas which we have arrived at before the introduction of the quantity $D_1 - D_2$.

The Ratio between Free and Solid Heights

Since $H = f + h$, we have, for compression springs:

$$H = \frac{\pi S h}{3 G d^2} (D_1^2 + D_1 D_2 + D_2^2) + h$$

$$= h\left[1 + \frac{\pi S}{G}\left(\frac{D_1^2 + D_1 D_2 + D_2^2}{3 d^2}\right)\right]$$

$$= h\left[1 + \frac{\pi S}{G}\left(\frac{D_1^3 - D_2^3}{3 d^2 (D_1 - D_2)}\right)\right]$$

In a similar way, for extension springs:

$$H = h\left[1 + \frac{2 P_x}{G}\left(\frac{D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3}{d^5}\right)\right]$$

$$= h\left[1 + \frac{2 P_x}{G}\left(\frac{D_1^4 - D_2^4}{d^5 (D_1 - D_2)}\right)\right]$$

By introducing the factor $(D_1 - D_2)$ the formulas are thus simplified as before, so that they may be readily solved with a table of cubes and fourth powers.

Deflection when only Free Height is Given

Considering first the compression type, we substitute the value of h as found from the formulas in the last paragraph, in the general formula for f. Hence:

$$f = \frac{H}{1 + \dfrac{G}{\pi S}\left(\dfrac{3 d^2}{D_1^2 + D_1 D_2 + D_2^2}\right)} = \frac{H}{1 + \dfrac{G}{\pi S}\left(\dfrac{3 d^2 (D_1 - D_2)}{D_1^3 - D_2^3}\right)}$$

In a similar way, for extension coils:

$$f = \frac{H}{1 + \dfrac{G}{2 P_x}\left(\dfrac{d^5}{D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3}\right)}$$

$$= \frac{H}{1 + \dfrac{G}{2 P_x}\left(\dfrac{d^5 (D_1 - D_2)}{D_1^4 - D_2^4}\right)}$$

General Considerations

In the compression type it is sometimes desirable to fix the heights, both free and solid, and afterwards ascertain the resulting capacity. If the heights so fixed exceed the allowable deflection by the compression formula, the spring will not return to its original free height. In other words, it will have taken a set. If the difference in heights is less than that of the compression formula, it cannot be assumed that there will be a uniform stress throughout the spring when solid, as there would have been, had the spring been built to the highest free height possible, and the capacity will not then be in proportion to the deflection. If the deflection, for instance, is one-half of the formula deflection, the capacity will not necessarily be one-half that of the strongest coil, instead of equal to that of the strongest coil. This type then appears indeterminable for capacity, the difficulty being to so pitch the coils as to assure uniform stress when the spring is solid. This difficulty does not present itself in cylindrical coils as we have a uniform stress at solid height.

Uniform stress at solid height in a conical spring requires a pitch of coils in proportion to the deflection of same at maximum stress, or, which is the same thing, in proportion to the diameters of the various elements. As the diametrical increase per unit of bar length is not a straight line formula, the pitch of coils necessary to gain uniform stress when solid would have to follow the law of a definite curve. While it may be possible to develop a machine which will so pitch these elementary coils, yet the demand does not seem to have developed such a machine.

Where the deflection is made originally greater than the

maximum stress will allow, the first compressions of the hardened spring will reduce the deflection to the maximum which the steel will stand. Thus, in such a case there is an assurance of uniform stress.

The laws governing the action of grouped cylindrical helical springs apply likewise to grouped conical springs. Briefly, the design should maintain the same free and solid heights throughout, which means that for all coils in the group the $\frac{D_1}{d}$ ratio should be the same, and the $\frac{D_2}{d}$ ratio should likewise be the same for all coils.

* * *

THE CUTLER-HAMMER MFG. CO.'S STUDENT COURSE

The Cutler-Hammer Mfg. Co., Milwaukee, Wis., has a course for training engineering graduates which differs in some essentials from those offered by other companies. The course embraces from three to six months of shop work in the various departments, from two to six months of testing room work, with additional time not specifically determined by any hard or fast rules, in the engineering department in designing work. In all cases the student is given an opportunity to use his own initiative. An attractive feature, from the student's point of view, of this course is that he is paid a salary which enables him to support himself, and to thus raise his self-respect. He is paid $60 a month for the first six months; $75 a month for the second six months; and $90 a month at the end of the first year. Progress beyond that figure depends solely on each man's ability and energy.

The company expects to meet with a loss in the training of these students during the first year, but it is expected that during the second and third years there will be an opportunity for returns on the investment, it being hoped that the students will remain for that length of time, observing the implied obligation. It is interesting to note that the company considers a pleasant personality a qualification for entering this student course. A disagreeable personality, it is stated, diverts the attention of the fellow workers from business, and hence involves a distinct loss.

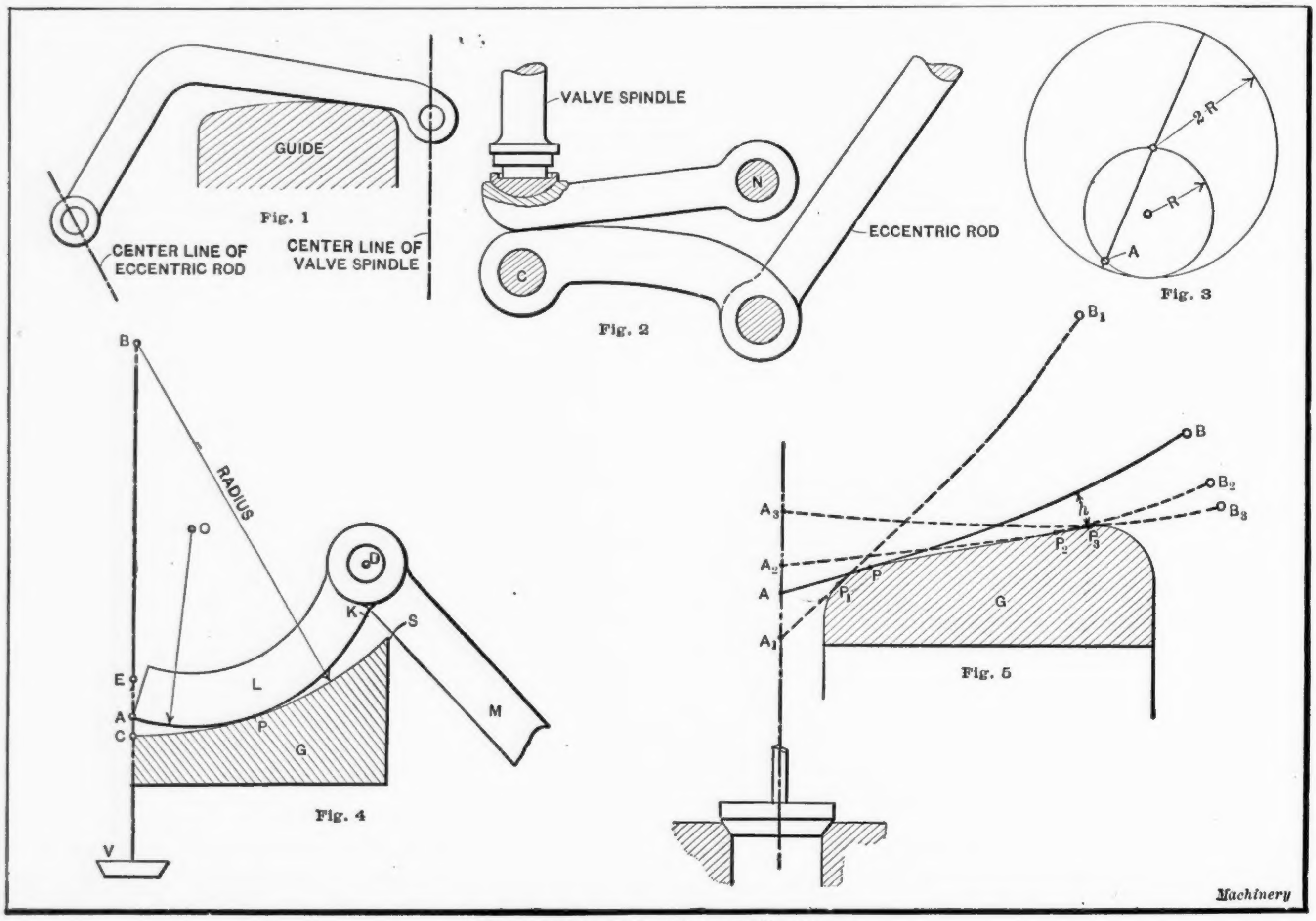
ROLLING LEVERS

By H. L. NACHMAN*

Rolling levers are commonly employed to actuate the valves of large gas engines as well as the poppet-type valves of steam engines, which are extensively used in Europe. These levers may be divided into two classes—the single-lever type shown in Fig. 1, and the double-lever type shown in Fig. 2. In the first case the lever rolls on a fixed guide, and has thus a continuously moving fulcrum, which travels from one end of the guide to the other. In the second case the levers are fulcrumed at fixed points, as at C and N, Fig. 2, and roll upon each other.

The levers should have a pure rolling motion in order to insure a minimum of wear. The valves should be opened quickly and should close with a constantly decreasing velocity, so as to seat quietly and without shock. It is not practicable to construct a mechanism that would fulfill these requirements with theoretical exactitude, but it may be of some interest to show how a simple pair of rolling levers that will approximately satisfy the requirements, may be designed. If a circle of radius R rolls inside of another circle, the radius of which is $2R$, as shown in Fig. 3, any point A in the small circle will travel along a straight line passing through the center of the large circle, as shown. In Fig. 4 the method of applying this principle to a valve motion is indicated. Here G is the fixed guide with a cylindrical surface of radius BC. The rolling lever L is actuated by a rod M. As the point of contact, P, travels from C to S, the point A will move from C to E along line CB. The valve stem is assumed to be attached at point A.

The example shown is a case of pure rolling motion. The point P is the instantaneous fulcrum of the rolling lever; therefore, the velocity of any point is proportional to its distance from this fulcrum. At the beginning of the motion the contact point is at C; hence the velocity of A is then zero. At the end of the motion the fulcrum is at S, and the velocity of A is to that of point D as AK is to DK. If M is actuated by an eccentric, as is usually the case, the valve will start to move slowly, its velocity being gradually increased to a maximum value, and will then again become zero at the end of the upward motion. The same action in reverse order takes place



Figs. 1 to 5. The Principles of Rolling Levers

* Address: 5309 Calumet Ave., Chicago, Ill.

on the downward stroke. The constructional difficulties of this mechanism, however, are such that it is not used in practice, and it must be modified to some extent. In its modified state, while there is not a pure rolling action, excellent results are nevertheless, obtained.

In both the single and double lever type it is usual to make one of the two elements straight, and find the proper curve of the other element, to give the desired motion to the valve. In the single-lever type it is necessary to continue the guide to the center line of the valve spindle in order to start the valve at a velocity of zero. This would require the guide to be forked, which, however, is not generally done, and, therefore, the lever will strike the spindle at the moment that the valve opens with a perceptible shock. The velocity at the end of the stroke, however, may be kept quite low by a suitable form of lever.

In Fig. 5 let P be the point of contact of the lever and guide at the moment when the valve starts to open. The velocity ratio of the lifting point A to the driving point B (assuming pure rolling motion) is as AP to BP. It is evident that this ratio increases rapidly as the contact point travels toward the right. The rate at which the velocity increases depends on the radius of curvature of the lever, and therefore on the distance h between the guide and the lever. The larger this distance is, the more slowly will the valve open. It is customary to make h from 1/16 to 3/8 inch. Near B the radius of curvature should increase, thus reducing the velocity of the valve as it comes near to its top position. This decreases the stresses in the mechanism due to inertia. For pure rolling action, point A and contact point P should always be in one straight line perpendicular to the path of point A. The distance of point P from this perpendicular is a measure of the amount of sliding. To eliminate side pressure on the valve spindle, the center line of the eccentric rod and of the valve spindle, and the common normal to the curves at the contact point must all meet in a common point.

The two rolling levers in Fig. 2 are used for operating the exhaust valve of a large gas engine. The condition of pure rolling is that the point of contact must always lie on a line joining the two fixed centers C and N, at which the levers are fulcrumed. Generally one of the levers is simply made straight, while the other is made of such curvature as to give the desired motion to the valve.

* * *

SOME DISADVANTAGES OF SPECIALIZATION

In an address on "Comparison between Industrial Conditions in the United States and Europe," read by Mr. A. L. Valentine of Hartford, Conn., before the American Society of Swedish Engineers, the disadvantages that sometimes are incident to a too highly developed system of specialization, were referred to. With relation to the training and experience of the men in charge of shops and departments, Mr. Valentine said:

"The superintendents and foremen in America are usually experts in their respective lines, which is evidently an advantage, although at times this special knowledge and skill is gained only at the expense of a more general understanding of shop work and mechanical matters. If special skill is gained in such manner, it may prove a disadvantage. No matter how efficient a man may be in doing a certain line of operations, it is evident that his usefulness would be increased if his knowledge were not confined entirely to the kind of work he is doing. In this particular respect it may not be out of the way to mention that in Europe the apprenticeship system is very much more developed than here, and that a man can hardly ever expect to hold as responsible a position as that of shop foreman, for example, who has not served an apprenticeship, and thus gained a general knowledge of mechanical matters. In this country, on the other hand, it is not unusual that a man who has operated but one kind of machine or machines will eventually take charge of a department of such machines. However great an importance there may be attached to special training, the general training will always be of supreme value."

* * *

Haste may make waste in tool grinding as well as in tool using.

ACTUAL AND CONSTRUCTIVE PATENT INFRINGEMENT—2

By E. D. SEWALL*

The deductions made in the previous installment of this article are not, it appears to the writer, wholly in accord with a number of recent decisions of the circuit courts and circuit courts of appeal, about to be referred to. The original doctrine of contributory infringement which has already been briefly set forth, in a narrow sense imposes restrictions on the public beyond the terms of the patent claims, although in a broader sense it does not, but deems the contributor to join with another in infringing the complete combination claimed. The cases about to be referred to, however, hold as contributory infringers persons who have not conspired with another to make or use, without authority, the patented thing.

A Dangerous View of Contributory Infringement

The first of these cases, decided in 1896, is the celebrated Heaton-Peninsular Button Fastener Company *vs.* Eureka Specialty Company, 77 F. R., 288, reversing the circuit court. Complainant was the owner of a patent for a machine for fastening buttons by stapling them to a shoe. It sold machines, made in accordance with the patent, having attached thereto a plate on which were delineated the following words: "This machine is sold and purchased to use only with fasteners made by the Peninsular Novelty Co., to whom the title to said machine immediately reverts upon the violation of this contract of sale." The fasteners were ordinary unpatented and unpatentable staples, adapted to be fed from a magazine on the machine. They had to be of a size to fit the magazine and were not claimed as a part of the combination patented. Defendant sold such staples to one of the purchasers of a patented machine. No demand for the return of the machine was made thereafter. The court was satisfied that defendant had knowledge of the contract of sale and held him as a contributory infringer, on the theory that although the machine had been sold to the purchaser the use had been restricted, and defendant had conspired with the purchaser to violate the use, the right to impose restrictions upon the use being a portion of the patentee's monopoly.

Another similar case is Cortelyou *vs.* Johnson, 145 F. R., 932, reversing the circuit court. In this case the patentee of a copying machine known as the "rotary neostyle" sold the machines under a restriction requiring the paraffined paper and the ink used with the machine, both unpatented, and forming no part of the machine claimed, to be purchased from the makers of the patented machine. Defendant was proven to have sold ink to a purchaser of the machine. The circuit court held him as an infringer of the patent, but the circuit court of appeals reversed the court below on the ground that it was not affirmatively shown that defendant had knowledge of the conditions, and the U. S. Supreme Court affirmed the court of appeals.

The Court's Statement of the Conditions

The circuit court of appeals in this case stated its intention to follow the Heaton Peninsular case when the facts were the same, even though "as an original question" they might have ruled differently. The court then points out the embarrassments likely to follow the application of this decision:

"When confined to articles, whether patented or not, which are made for the express purpose of inducing infringement and are not intended for any legitimate use, the doctrine of contributory infringement is logical, just and salutory. But we doubt the wisdom of extending it to the ordinary commodities of life, used in connection with a patented machine, because the patentee sells or licenses the machine upon the condition that he alone is to furnish those commodities. Care should be taken that the courts in their efforts to protect rights of patentees do not invade the just rights of others engaged in legitimate occupations, by creating new monopolies not covered by patents and by placing unwarrantable restrictions upon trade. We think it is clear that the doctrine may be carried far enough to produce such results. For instance, should the patentee of a fountain pen, by such a notice as we have under consideration, be permitted to hold as an infringer one who sells ink to the owner of the pen even though he knows the restrictions? To compel the dealer to make

* Address: 2106 F St., N. W., Washington, D. C.

inquiries and take the precautions necessary to save himself from being sued as an infringer would place intolerable burdens upon business. . . . If the doctrine be driven to its ultimate conclusion, the merchant and the consumer may find themselves enmeshed in a network of monopolies embracing all the necessaries of life. No one may safely sell coffee to the consumer but the patentee of his coffee mill, no one can furnish him flour but the patentee of his baking pans, and he may yet be compelled to buy milk from the patentee of his milk can and soap from the patentee of his bath tub."

The Indefinite Meaning of the Law

This is a very forceful statement of the evils of the doctrine; but it alleges no definite legal ground whereby these evils may be checked, and leaves the question to be decided on a consideration of the mere degree of the restraint imposed, or the particular things with respect to which the restraint applies. If the restraint applies to the sale of soap and flour perhaps it may not be sustained; but if it applies to ink or wire perhaps it may be sustained.

In Dick *vs.* Milwaukee Specialty Co., 168 F. R., 930, defendant was held guilty of infringement for selling, with knowledge of a restriction, unpatented ink to be used with a patented copying machine known as a mimeograph. In Crown Cork & Seal Co. *vs.* Standard Brewery, and same *vs.* Greenberger, 174 F. R., 252, the Brewery Co. was held to be an infringer of a patented machine purchased by it under a restriction that only crown seals (not patented) made and sold by the patentee of the machine should be used with it, because it used seals made and sold by another. Here the court said defendant was liable "*even though he buys and pays for the machine and is vested with the legal title thereto*, and its use by him in violation of such restriction is an infringement of the patent." Greenberger, who furnished the crowns, was held guilty of contributory infringement. In Commercial Acetylene Co. *vs.* Autolux Co., already referred to, the defendant company was held for contributory infringement not only because it aided in reconstructing the patented package, but on the further ground that it had aided in violating a license agreement set forth on a plate secured to the receptacle.

These last cited cases, it will be seen, hold that under the patent laws, although one has bought a machine and paid the full price for it and obtained the legal title to it, he may not use it except in accordance with the wishes of the patentee, if any be expressed, and that the patentee may restrain trade in unpatented supplies used with a patented machine. There are many other cases to the same effect, all based on the decision rendered in 1896 in the case of Heaton-Peninsular Co. *vs.* Eureka Supply Co.

In view of the doctrine of the Heaton-Peninsular case, it has also been held that where a patented machine has been leased on condition that unpatented supplies therefor be purchased from the patentees, it is contributory infringement for a third party to furnish such supplies to the licensee with knowledge of the conditions of use. In Tubular Rivet Co. *vs.* O'Brien (93 F. R., 200), defendant was held liable under the patent laws for supplying to a licensee of a patented machine tubular rivets of a well-known kind in common use, because the license agreement required the licensee to purchase such rivets only from the licensor. Similarly, in Rupp, *et al.*, *vs.* Elliott, (131 F. R., 730), one who supplied ordinary wire to be used by a licensee in a patented machine was held to be an infringer.

The Right to Fix Resale Prices on Patented Articles

Another form of ultra-claim infringement, by judicial interpretation, consists in the resale, by a purchaser, of a patented device at a price less than that fixed by the patentee as the resale or retail price. This interpretation of the law is also ostensibly based upon the opinion in the Heaton-Peninsular case. In Victor Talking Machine Co. *vs.* The Fair (123 F. R., 424), one of the leading cases on this point, patented talking machines were sold to a department store subject to a condition appearing on a plate fixed on each machine that they should not be resold at a price less than $25. The department store offered them for sale at $18 each, and on appeal to the circuit court of appeals was held to be guilty of infringement of the patent and enjoined from making any further sales at cut prices. In Automatic Pencil Sharpener Co. *vs.* Goldsmith Bros. (190 F. R., 205), the rule was stated as follows: "The owner of a patent may sell the patented article under restrictions as to the price at which it shall be resold, and is entitled to an injunction to restrain a violation of such restrictions, by one having full knowledge of them, as an infringement of the patent."

In the case of Edison *vs.* Smith Mercantile Co. (188 F. R., 925), the facts, as appears from the decision, were substantially as follows: Patented talking machine records were made and sold by the patentee subject to a restriction on the price at which they were to be resold. The stock of Edison records in the store of an authorized dealer became damaged by fire. Some cartons containing the records were smoked, others blackened, and others more seriously injured. The stock was abandoned to an insurance company which took it over. The insurance company sold the stock to a salvage company and the latter sold the records in question in the case to the defendant who sold them at retail at less than the resale price fixed by the complainant, the patentee. Defendant was held to be an infringer of the patent for the record. The court remarked with reference to the language of the resale restriction imprinted on the records and the cartons containing them: "Whether the language in question effectively operates in this way after the article has once reached the ultimate user, and has been used, is a question not presented by this record, and which may not be in all material respects the same question as the present one."

There are other cases on the same point decided in the same way; but in the District of Columbia, in an application by the patentees of a medicine known as "sanatogen," for an order restraining a druggist from selling sanatogen at a cut price as an infringement of the patent, the order was denied by the Supreme Court of the District of Columbia without comment. (Bauer Chemical Co. *vs.* O'Donnell, August 4, 1911.)

Review of the Present Conditions

The class of cases of which Dick *vs.* Milwaukee Specialty Co. is a representative, holds that the patent law may be used to restrain trade in unpatented materials to be used with a patented machine which has been sold by the patentee, and legal title to which has passed from the patentee. This ruling nullifies with respect to patented articles the general rule of common law that the owner of a chattel is entitled to the free and innocent use thereof, and appears to nullify the common law, and the state and federal statutes against contracts in restraint of trade, which are, in the language of Mr. Justice Holmes, "contracts with a stranger to the contractor's business (although in some cases carrying on a similar one) which wholly or partially restrict the freedom of the contractor in carrying on that business as he otherwise would." (Northern Securities Co. *vs.* U. S., 193 U. S., 197.)

The class of cases of which Rupp *et al.*, *vs.* Elliott is a representative, holds that the patent law may be invoked to restrain trade in unpatentable materials to be used with a patented machine which has been leased, and likewise appears to nullify to a like extent the laws against contracts in restraint of trade.

The class of cases of which Victor Talking Machine Co. *vs.* The Fair is an example, holds that the patent law may be used to prevent a purchaser and holder of the legal title to a patented article from selling it at a price lower than that dictated by the patentee, thus nullifying to that extent the general rule of law against restrictions on alienation. "If a man be possessed of a horse or any other chattel, real or personal, and give his whole interest or property therein, upon condition that the donee or vendee shall not alien the same, the same is void, because his whole interest and property is out of him, so as he hath no possibility of reverter, and it is against trade and traffic and bargaining and contracting between man and man." (Hughes, J., quoting from Coke on Littleton in Dr. Miles Medical Co. *vs.* Park & Sons, 220 U. S., 373.)

In the case of Dr. Miles Medical Co. *vs.* Park & Sons, the U. S. Supreme Court held that such a contract with respect to an unpatented proprietary medicine was a contract in restraint of trade, and void so far as it affected interstate commerce. The same court has held that a like contract with respect to the price at which copyrighted books should be re-

sold, is not sustainable as a right conferred by copyright. saying: "To add to the right of exclusive sale the authority to control all future retail sales by a notice that such sales must be made at a fixed sum, would give a right not included in the terms of the statute, and, in our view, extend its operation by construction beyond its meaning." (Bobbs-Merrill Co. *vs.* Strauss, 210 U. S., 339, Day, J.)

In all three classes of cases above, the injury to the patentee was breach of contract, a wrong which the state courts and general law and equity are capable of dealing with, and was not an infraction of a patentee's right to exclude others from making, using or selling the invention, and there was no need therefore to resort to the patent law, and no remedy in the patent law appropriate to the wrong.

What Can be Done to Change the Present Situation?

Ordinary citizens, unlearned in the law, and accustomed to believe that the people, in consenting to the grant of a patent, have consented only to refrain from making, using and selling without permission from the patentee that which is defined in the claims of the patent, evince surprise and resentment when they learn that they may also be restrained by the law from making, using and dealing in ordinary unpatented articles of commerce; from deriving the protection of the general laws against restraint of trade when patented articles are involved; from selling at any price they see fit patented articles that they have bought. They begin to ask themselves whether they are not paying too high a price for the benefits derivable from public encouragement of invention. The people forced the annulment of the registration law of 1793 because of the abuses that grew up under it, and the enactment of the present law in its place in 1836. Since that time industrial conditions have changed. Trusts and corporations established for the purpose of monopolizing trade and manufacture prevail everywhere, and if the patent laws are to be construed to aid restraints of trade beyond those which the people consented to submit to by the grant of patents, the people are likely to demand, finally, their amendment or abolition.

Action in Great Britain

Already the English people have declared their intolerance of any interpretation that shall enable a patentee to monopolize more than the patent grants, urged thereto by practices of American corporations upheld by American courts. The British patent act of 1907 thus declares:

"Sec. 38. (1). It shall not be lawful in any contract made after the passing of this Act in relation to the sale or lease, or license to work, any article or process protected by a patent, to insert a condition the effect of which will be

(*a*) to prohibit or restrict the purchaser, lessee, or licensee from using any article or class of articles, whether patented or not, or any patented process, supplied or owned by any person other than the seller, lessor, or licensor, or his nominee; or

(*b*) to require the purchaser, lessee, or licensee to acquire from the seller, lessor, or licensor, or his nominees, any article or class of articles not protected by the patent;

and any such condition shall be null and void, as being in restraint of trade and contrary to public policy."

Action in the United States

The people of the United States, by their representatives in Congress, are showing their dissatisfaction with ultra-claim restraints enforced under the cloak of patents, as appears from proceedings in the last session of Congress. On May 8, 1911, a concurrent resolution was submitted in Congress resolving: "That a joint committee of both Houses of Congress is hereby created . . . empowered and directed . . . to ascertain the methods of sale, leasing, disposing and control of patented articles in the United States; to ascertain whether patents are used or misused in the establishment of industrial trusts or monopolies; and to investigate all other matters material or pertinent to the purposes of this resolution, and to report their findings to Congress with recommendations as to any needful legislation to protect the public interest and to promote the general welfare."

Among other bills to amend the patent laws introduced in Congress is Senate Bill 2158, "To protect trade and commerce against unlawful restraints and monopolies," providing (Section 8) "that every person engaged in any business, any portion or all of which constitutes a violation of this Act, shall forfeit by reason of such violation any and all rights which such person may have to protection under or right to damages for infringement upon any patent right held or owned by such persons, whether directly from the United States or under purchase, assignment or otherwise; and the right to the free manufacture and use of any and all articles, devices, or machines so held under right of patent by the person who shall have violated any of the provisions of this Act, shall thenceforth be open to all."

House Bill 2930 provides "that whenever any letters patent issued by the United States, or any article, commodity, compound, device, mechanical appliance, or machine protected by patent . . . is owned, leased, used, or controlled by any individual, firm, association, syndicate, corporation, or combination which is engaged in any vocation, business, or enterprise in violation of any law of Congress or of any state, prohibiting, restraining or regulating trusts, monopolies, or combinations in restraint of trade, the right to any protection under the patent laws of the United States shall cease and terminate."

House Bill 8661 reads as follows: "That no owner, proprietor, or beneficiary of any letters patent of the United States covering any tool, implement, appliance, or machinery shall, directly or indirectly, by any means or device whatsoever, make it a condition or provision, expressed or implied, of any sale or lease of, or license to use, any such tool, implement, appliance, or machinery, that the purchaser, lessee, or licensee thereof shall not buy, lease, or use, whether in connection with the operation or use of such tool, implement, appliance, or machinery, or otherwise, machinery, tools, implements, appliances, material, or merchandise of any person, firm, corporation, or association, other than such vendor, lessor, or licensor; nor shall any such owner, proprietor, or beneficiary of any such letters patent, directly or indirectly, by any means or device whatsoever, revoke any such sale, lease, or license made by any such owner, proprietor, or beneficiary, on account of the purchase, lease, or use by any such purchaser, lessee, or licensee, of machinery, tools, implements, appliances, material, or merchandise of any person firm, corporation, or association, other than such vendor, lessor, or licensor: Provided, that nothing in this Act shall be construed to prohibit the appointment of agents or sole agents to sell or lease machinery, tools, implements, or appliances.

"Sec. 2. That any such owner, proprietor, or beneficiary of any such letters patent who shall violate the provisions of this Act, and any other person, whether or not an agent of such owner, proprietor, or beneficiary, who shall wilfully assist in, or become a party to, any such violation, shall be punished for each offense by a fine not exceeding five thousand dollars."

Conclusion

Those who attain to power from the exercise of special privileges are very apt to reach for more. Corporations that have become wealthy through the monopoly of patents have grasped for further monopolies of things not protected by patents, and of things which though patented have been sold, returned their profits, and passed without the monopoly. And in this they have been sustained by U. S. courts, but not yet by the Supreme Court.

If the patent statutes do accord this ultra-claim privilege to a patentee, it is apparent that the people are going to change the statutes. Whether they do accord this privilege or not cannot be deemed settled until the Supreme Court shall have passed upon it. "A question arising in regard to the construction of a statute of the United States concerning patents for inventions cannot be regarded as judicially settled when it has not been so settled by the highest judicial authority which can pass upon the question." (Andrews *vs.* Hovey, 124 U. S., 694, Blatchford, J.)

The question may therefore be regarded as still open to discussion. If the patent statutes do not sustain the patentee's right to put a restraining hand on trade beyond the right to exclude others from making, using and selling the thing claimed in his patent, it would be inadvisable to complicate the statutes by the addition of declaratory sections, and by the possible imposition of drastic qualifications out of sympathy with the spirit of patent law.

A good law by inaccuracy or laxity of administration and interpretation may prove as injurious to the community as a bad law accurately applied. If some things that are done and permitted in the name of patent law are warranted by it, the law ought to be amended, or perhaps even abolished. But if such things are unwarranted by it, the remedy lies in more accurate administration and more careful application. The writer thinks the United States patent law, accurately applied, is, as it was expected to be by its framers, promotive of public welfare. Possibly it may be advantageously amended in minor particulars, but as a body of statutes it is believed to have no superior in its particular field. It would be unfortunate if the greed of those who have been granted special privileges by the patent law, in grasping for further privileges under the cloak of that law, should arouse such resentment in the people as to force hasty and drastic legislation where none is needed. The warning words of Professor Robinson are worthy of heed by all friends of the patent privilege: "Continued concessions to the patentee are as unjust, and ultimately as disastrous, as continued restrictions of his powers; for they constantly give rise to new grounds of litigation and are sure to produce, at some time, a reaction in public sentiment under whose impulse the entire system of exclusive privileges may disappear." (Robinson on Patents, Vol. 1, section 23.)

* * *

An automobile fire engine in Newark, N. J., was recently disabled when responding to a fire call by a fireman's coat, that had carelessly been thrown over a rear wheel becoming jammed between the driving chain and sprocket. The chain was broken and other damage done that put the machine out of use for several days. The accident is but another illustration of the folly of building motor trucks with unprotected chains and sprockets.

DIAGRAM FOR FINDING HORSEPOWER TRANSMITTED BY WORM-GEARING

By F. A. G.

A great many manufacturers of worm-gear drives in Europe build and guarantee drives for a given horsepower at a given speed. The accompanying diagram is one which has been used to determine the necessary factors in this connection in the designing-room of a large gear factory. The diagram makes it very simple to find the pitch of the gearing, if the speed of the worm and the horsepower are given. The most important rule for worm drives is to keep the diameter of the worm as small as possible. The diagram, therefore, gives for each pitch and each horsepower and speed the largest allowable pitch diameter of the worm. Under no circumstances is it advisable to make the pitch diameter of the worm larger than allowed by the diagram, as the gearing may then run hot

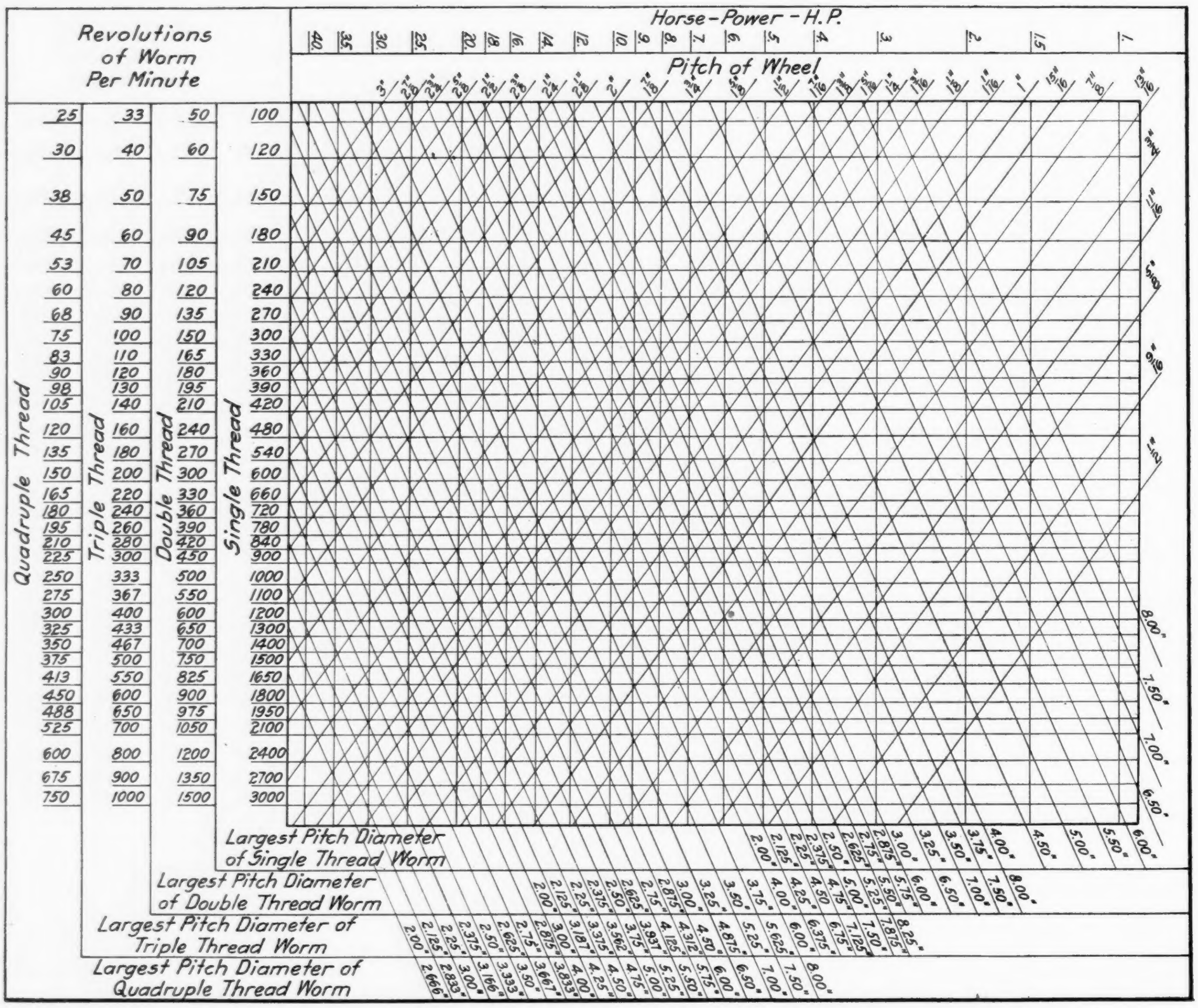


Fig. 1. Diagram of Relation between Horsepower, Pitch and Revolutions per Minute of Worm Gearing; Gear, Phosphor-bronze; Worm, Hardened Steel

and start to cut. On the other hand, there is no objection to making the pitch diameter smaller. The larger the lead of the worm the greater is the efficiency. In order to obtain the best results, double or triple threads should be used for the worm.

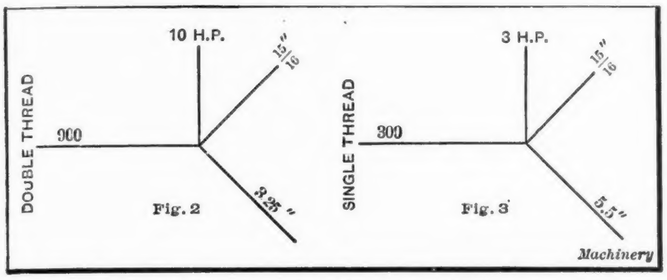
For cast-iron worm-wheels and worms with unfinished teeth, the pitch should be 1.33 times greater than that obtained from the diagram, as this is prepared for worm drives with cut teeth, made from any suitable materials. In the case of unfinished teeth, the pitch diameter of the worm should be only 0.8 times that given in the diagram.

The best material for worm gearing is hard phosphor-bronze

* The following articles on this and kindred subjects have previously been published in MACHINERY: "Table for Calculating the Outside Diameter of Worm-wheels," April, 1911; "Allowable Load, and Efficiency of Worm Gearing," September, 1910, engineering edition. See also the previously published information referred to in connection with the last-mentioned article.

for the worm-wheel and hardened steel for the worm. The next best materials are cast iron for the worm-wheel and hardened steel or cast iron for the worm. Steel or steel castings for both the worm-wheel and worm are only allowable for slow speeds. The teeth in the worm-wheel and the thread on the worm should always be cut, whenever the gearing is to be used steadily or at a reasonably high speed.

As an example of the use of the diagram, assume that an electric motor making 900 R.P.M. is to transmit 10 horsepower by means of worm gearing, the ratio of which is to be 1 to 30. By entering the diagram as indicated in Fig. 2, we find that for single thread, the pitch should be about 1⅛ inch. This would make the pitch diameter too small, and therefore the use of a double thread is necessary. In that case



Figs. 2 and 3. Diagrams indicating Use of Diagram in Fig. 1

the pitch will be about 15/16 inch, and the maximum pitch diameter of the worm somewhere about 3¼ inches. These factors having been found, the diameter of the worm-wheel, the center distance, and other necessary dimensions are determined as usual.

A lathe requiring 3 horsepower is to be driven through a cast-iron worm-wheel. The worm makes 300 R.P.M., and the speed ratio is to be 1 to 90. By entering the diagram as indicated in Fig. 3, we find that a pitch of 15/16 inch would be satisfactory for a phosphor-bronze worm-wheel, but for a cast-iron worm-wheel the pitch should be 1.33 times larger or equal to about 1¼ inch. The pitch diameter of the worm-wheel is found in the usual manner, the worm being assumed to have a single thread.

* * *

The American Society of Automobile Engineers has undertaken the standardization of motor trucks. At a recent meeting of a committee of the society it was decided tentatively that a motor truck should be capable of rendering normal or continuous service under its tonnage rating, and should have an overload capacity, for temporary or emergency service, of 25 per cent above its normal capacity. It was recommended that the desirable speed of trucks of various capacities should be as follows:

For 1-ton trucks	15 miles per hour
For 2-ton trucks	12 miles per hour
For 3-ton trucks	10 miles per hour
For 4-ton trucks	9 miles per hour
For 5-ton trucks	8 miles per hour

* * *

It is reported by Consul-General John E. Jones, of Winnipeg, Manitoba, that an industrial exhibition will be held this year in Winnipeg which will be the largest and most important ever held in Western Canada. The exhibition will be opened on July 10. The secretary and treasurer of the exhibition is Dr. A. W. Bell, Chamber of Commerce, Winnipeg.

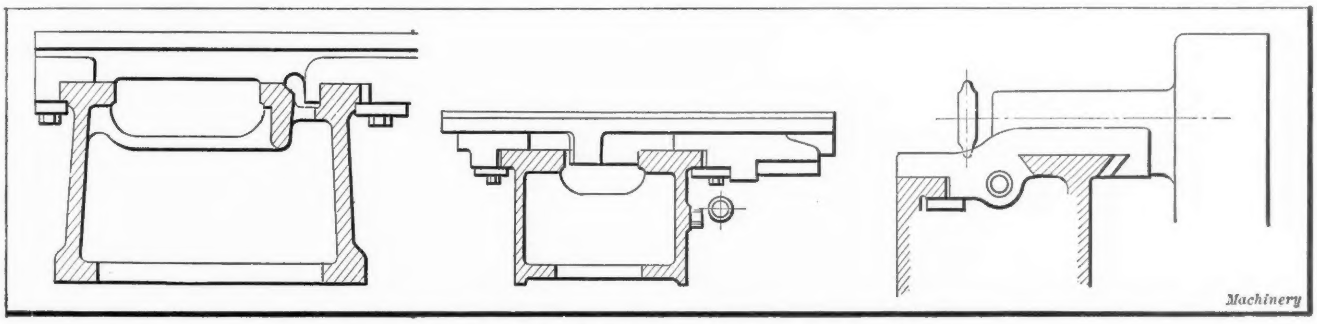
THE ADVANTAGE OF THE "NARROW GUIDE"*

By H. T. MILLAR†

The analytical faculty is very necessary in designing, for although it is the constructive ability which is brought into play when planning a structure or mechanism, this latter should also be analyzed for agreement with mechanical laws. It seems unfortunate that there is not more of critical analysis published in the technical press, since the contributors often have special facilities for it. These remarks are especially prompted by the article by Mr. J. G. Horner on "The Forms of Lathe Beds" in the February number of MACHINERY. In discussing the "narrow guide" lathe bed, Mr. Horner states that in the last five or six years it has effected a revolution in lathe construction. There is no analysis, however, of the claims made for it, and it is, therefore, the purpose of the writer to analyze the conditions of guiding surfaces, and the narrow guide in particular.

The question of the advantage of the narrow guide does not enter a great deal into American lathe design. If there has been any tendency to alter American designs, it has been away from the principles of the narrow guide, since the inverted V is perhaps the most highly developed instance of the principle, and the tendency has been to increase its included angle on account of the vertical pressure. The question arises, however, in American designs of other machines.

The accompanying illustrations Figs. 1 and 2 are taken from Mr. Horner's article and illustrate lathe carriages made by J. Lang & Sons, Johnstone, and J. Stirk & Sons, Halifax, respectively. Fig. 3 shows an example of American practice as embodied in a Brown & Sharpe gear cutting machine. Referring to Figs. 1 and 2, Mr. Horner says: "It is possible with these designs to obtain a length of guide of as much as ten times the width between the guiding surfaces, which has the effect of producing a steady motion with a greater



Figs. 1 to 3. Different Designs embodying the Narrow Guide

amount of freedom from twisting than is the case when the saddle fits on the front and rear outer edges of the shears."

In other words, according to this, the amount of cross-wind is a function of the ratio of the length of a slide to its width, and hence the narrower a slide is made in proportion to its length, the less would be the cross-wind for a given amount of clearance between the strip and the slide. This is accepted almost as an axiom by many machine-tool designers. It can easily be shown, however, that this is not so, and that for a given length of slide and a certain clearance between the strip and the slide, the amount of cross-wind is unaffected by the width between the guiding surfaces. This was shown by a contributor in the April number of MACHINERY, and, in order to make the present analysis of conditions complete, it will be briefly reviewed here. Fig. 4 illustrates in diagrammatic form two slides superimposed. They are similar in every respect, except that one has a narrow guide and the other fits on the front and rear edges of the shears. Let w be the width of the narrow guide and W the width of the ordinary guide; let K be the clearance between the slide and the strip, and ϕ and ϕ_1 be the respective angles of cross-wind, which in this case may be regarded as infinitesimal. Then triangle ACE is similar to triangle APO; hence AE is proportional to

* See MACHINERY, April, 1912, "Narrow vs. Wide Guides for Machine Tools," and January, 1912, "The Introduction of the Narrow Guide on Machine Tools."

† Address: 150 Waterloo Road, Manchester, England.

OA, and triangle $A_1C_1E_1$ is similar to triangle A_1PO; hence A_1E_1 is proportional to OA_1.

The angle of cross-wind for width W (in radians) $= \dfrac{AE}{OA}$

and for width $w = \dfrac{A_1E_1}{OA_1}$.

Therefore, for a given length of slide and clearance K the amount of cross-wind is independent of the widths W and w.

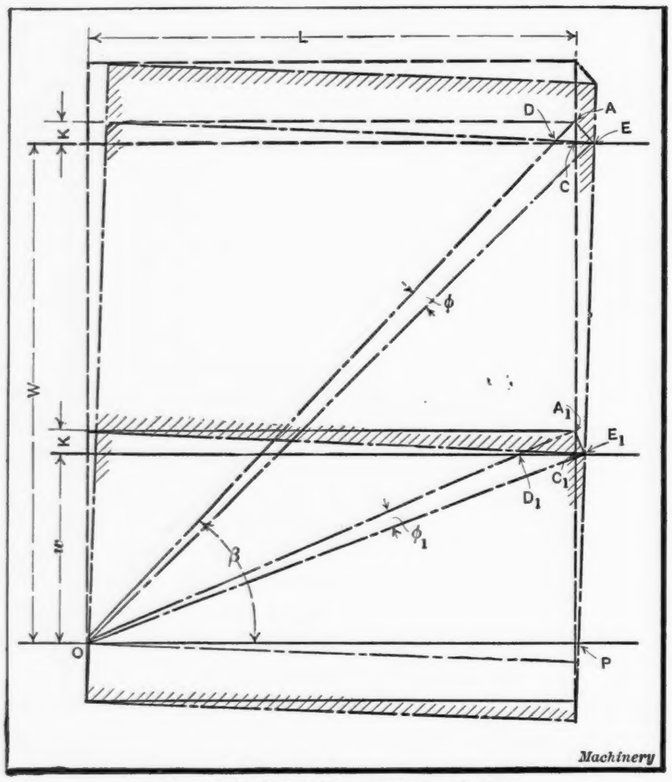


Fig. 4. Analysis of Cross-winding Action

The fact that the angle of cross-wind is a function of the strip clearance K and the length of the slide does not seem to have suggested itself to most writers on the narrow guide, but it will be easily seen that this is so.

The backlash or clearance K is equal to AC. Then,

$$AE = \frac{AC}{\cos\beta};\quad OA = \frac{OP}{\cos\beta}.$$

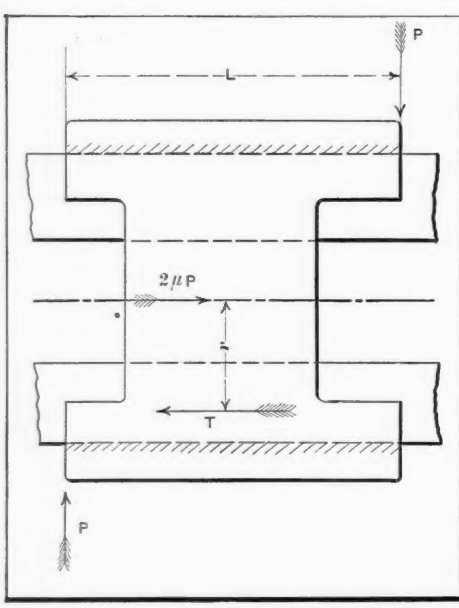


Fig. 5. Analysis of Frictional Resistance and Leverage

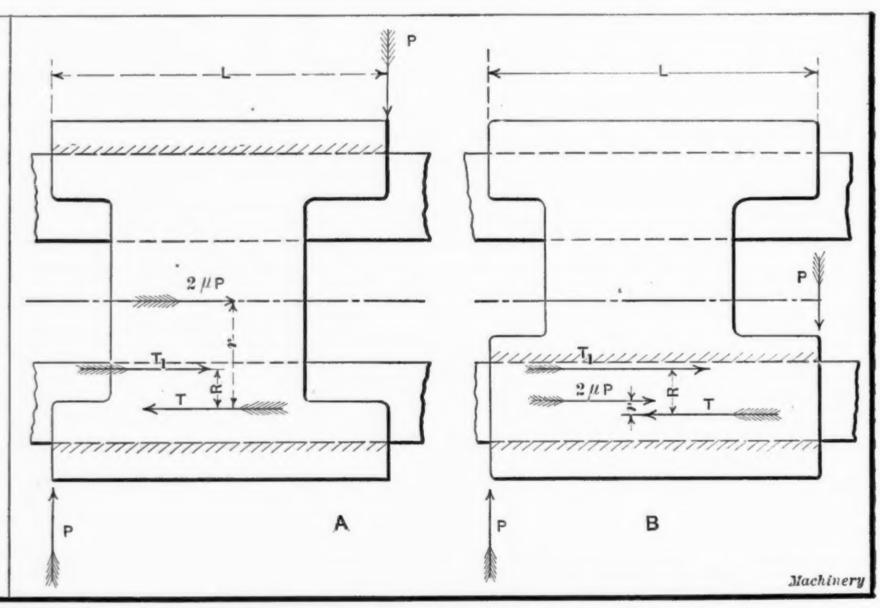


Fig. 6. Comparison between Wide and Narrow Guide

$$\text{Cross-wind} = \frac{AE}{OA} = \frac{AC}{OP} = \frac{\text{clearance}}{\text{length of slide}}$$

From this it is apparent that the narrowing of the width between the guiding surfaces does not directly affect the angle of cross-wind. When a generally held reason for an accepted practice is disposed of by mathematical considerations, it is wise to look around for another reason. It is not safe to dismiss a point too quickly which has been accepted and in practice for a considerable time. In this case, the narrowing of the distance between the guiding faces may have advantages, although it does not affect the angle of cross-wind. One advantage is that the chance of closing in the bed by setting up the strip too tightly is avoided. This, however, is probably not a very important point. Mr. Horner, elsewhere in his article, suggests what appears to the writer to be the chief advantage of the narrow guide. He says: "In conjunction with this, it is also the practice to bring the lead-screw as close as is practicable to the guide ways, and the twisting tendency and friction caused by the old-style construction is minimized. Thus the force is applied at the correct place near the guide ways."

It is in the resultant improvement in the relative positions of the feeding force, the resistance, and the guides, that the advantage of the narrow guide lies. In the case of the lathe, the narrow guide in front is near to the resistance due to the cut and the feeding force of the rack or lead-screw. If we take a general case of a slide moved forward by a force eccentric to the guides, and neglect for the moment any resistance due to the cut and friction on the top of the bed, we shall see that there is a limiting case for the proportion which the eccentricity of the force bears to the length of the guides. In Fig. 5 is a diagrammatic view of the slide, where T is the propelling force with the eccentricity r; P is the resultant pressure on the guides. Let μ be the coefficient of friction; then $T \times r = P \times L$, or $T = \dfrac{P \times L}{r}$. The resistance to motion (excepting the cut, friction on top of bed, etc.) equals $2\mu P$, and is assumed to act midway between the guides. Hence,

$$2\,\mu\,P = T = \frac{P \times L}{r},\ \text{and}\ \frac{L}{r} = 2\,\mu$$

Hence, if the ratio of the length of a slide to the eccentricity of the propelling force is not at least as great as the ratio of 2μ to unity, it is impossible to move the slide. Since the coefficient of friction is not likely in this case to exceed 0.1, and will probably be less, the limiting case for movement under these conditions would be when $L = 1/5r$, or, in other words, when the eccentricity of the feeding force is five times the length of the slide. The conditions in practice, of course, never reach this minimum.

In practice, however, the case is complicated by the addition of other resistances—resistance due to the cut, the friction on the top of the bed, and the sliding friction of the shaft bearings. Since the shaft generally revolves, this latter friction is very small. The effect of the friction on the top surface of the bed varies a great deal in different cases. The resist-

ance due to the cut is the greatest, and in the case of lathes varies in position, and consequently the moment varies. The conditions which obtain due to the cutting resistance are illustrated in Fig. 6, where, at A, is shown the ordinary construction with a wide space between the guide surfaces, and at B the conditions obtaining in a lathe with narrow guide. Let T_1 be the resistance due to the cut; T, the feeding force, and P the pressure on the guide as before. We see then that $2\mu P + T_1$ must not exceed T if movement is to take place.

$$PL = Tr - T_1(r - R) = Tr - T_1r + T_1R \qquad (1)$$

$$2\mu P = T - T_1 \qquad (2)$$

From (1) we get

$$T - T_1 = \frac{PL - T_1R}{r}$$

$$2\mu P = \frac{PL - T_1R}{r}$$

$$2\mu = \frac{L}{r} - \frac{T_1R}{Pr}, \text{ or } \frac{L}{r} = 2\mu + \frac{T_1R}{Pr}$$

In the limiting case, then, the minimum proportion for the length of the slide to the eccentricity of the feeding force is, of course, greater by the amount $\frac{T_1R}{Pr}$, than in the former case.

We can now see the reasons for the advantages of the narrow guide. The frictional resistance of the guiding surfaces may be assumed to act midway between them. If the position of the guide is such that this resistance has a small moment the conditions are improved. Comparison of the conditions in A and B, Fig. 6, illustrates the advantage of the narrow guide. It is evident that if the direction of the feeding force and the direction of other resistances were in the same straight line, the width between the guiding surfaces would be immaterial; in fact, no guides would be necessary. This is, of course, a condition impossible to attain in practice.

Conclusions

In conclusion it may be stated:

1.—That the width between the guiding surfaces does not affect the angle of cross-wind, but that this is a function of the length of the slide and the clearance between the strip and the bed.

2.—That the narrow guide has advantages, but that these advantages are dependent mainly upon its correct location: It must be placed close to the resistance and the feeding force; a narrow guide strip at the back of the carriage would probably be more detrimental than the ordinary wide guide. For the same reason, in American tool construction only one V and one flat way are used. The V must be nearer to the feeding force and the resistance.

3.—That when the narrow guide is placed near to the feeding force, its advantage lies in the reduction of the moment of the frictional resistance and the required feeding force.

4.—That some advantage is derived from the better mechanical construction possible with the narrow guide, since the guiding surfaces cannot be closed in, and most makers fit a taper strip in place of the common angle-strip set up with the points of screws acting against it.

* * *

On March 7, Henri Selmet, a Frenchman, flew in an aeroplane from London to Paris, a distance of 222 miles, in 2 hours and 57 minutes, without alighting anywhere on the way. This is the most remarkable record ever made in fast flying, the average speed for three consecutive hours being 75 miles an hour. The flight was made in a storm accompanied by very high wind, and most of the time in a drenching rain. While this weather, of course, increased the dangers of the flight, the speed made could probably not have been accomplished if it had not been that the aviator was riding on a favoring gale, the same as do birds of migration. Even if the aeroplane should become actually useful in the future as a means of transportation under certain conditions, it is very likely that it will be necessary to make a close study of wind conditions, and to arrange flights so as to take advantage of favorable air currents.

* * *

It should no longer be a question of whether or not you need or desire safeguards around machinery. The only question for debate now is, which kind.—*The Wood-Worker.*

DETERMINATION OF HELIX ANGLES*†

By GEORGE W. BURLEY‡

When calculating the angles of helices or spirals (as they are usually, though wrongly, called) for setting the tables of universal milling machines, the heads of twist-drill flute milling machines, etc., it is necessary to employ the formula:

$$\tan a = \frac{\pi D}{L}$$

in which

a = the helix or spiral angle required,
D = the diameter of the work,
L = the lead of the helix or spiral.

Having calculated the value of $\pi D \div L$ for any particular case, the next step in the process is the consultation of a table of natural tangents for the determination of the value of a from tan a. To do away with calculations and consultation of a trigonometrical table, the table in the accompanying Data Sheet Supplement has been prepared, this table giving the values of the helix or spiral angles for a large number of values of the ratio of L to D. For the determination of the helix or spiral angle for any value of $L \div D$ not included in the table, the "simple proportion" method will give a result sufficiently exact, owing to the slight differences between consecutive helix-angle values in the table.

As an illustration, let us suppose that we wish to determine the value of the helix or spiral angle for a case when $L \div D = 3.75$. Consulting the accompanying table we find that when $L \div D = 3.70$, $a = 40$ deg. 21 min., and when $L \div D = 3.80$, $a = 39$ deg. 35 min. Therefore, when

$$\frac{L}{D} = 3.75,\ a = \frac{40^\circ\ 21' + 39^\circ\ 35'}{2} = 39^\circ\ 58'.$$

This is the same value that would be obtained if the formula above were used, there being no difference between the exact value and the approximately calculated value of the angle. This is a very close result, but in no case is the difference between the two values greater than 7 minutes, and this only where the angle is in the neighborhood of 90 degrees, so that the percentage of error is very slight, and, therefore, negligible.

* * *

PROPOSED INSTITUTION OF MACHINE TOOL ENGINEERS

A society, known as the Institution of Machine Tool Engineers, is proposed by the *Practical Engineer*, London. This journal points out that the Institution of Mechanical Engineers in England is not giving the subject of machine tools a great deal of attention, and that, in many cases, not only the quantity but the quality of papers on machine tool design, presented before this society, has been rather unsatisfactory. In most cases, the only thing that has been done has been to discuss finished machines in a way similar to that in which a salesman discusses his own and his competitors' products. The designer's side of the subject of machine tool design has, in nearly all cases, been left severely alone. There is also need for standardization, which a society of machine tool designers would be able to accomplish in a more satisfactory manner than the larger societies. Some of the opinions stated by the *Practical Engineer* in drawing a picture of British conditions are true of conditions in this country. Our engineering societies have done little to gather and distribute information dealing with the design of machine tools, notwithstanding the fact that the machine tool industry is, so to speak, the basis of all machine building industries.

* * *

It is claimed that soap water used instead of ordinary water in mixing concrete makes it waterproof. A grain elevator, at times exposed to inundation, was built in Germany from reinforced concrete made with soap water, and this building was successful in withstanding the effect of the water, while another building of the same material, but having been made without soap water, failed to completely keep out the water.

* With Data Sheet Supplement.
† See also MACHINERY'S Data Sheet No. 93, "Table Giving Lead of Spiral for Given Angle," and MACHINERY'S Data Book No. 6, "Bevel, Spiral and Worm Gearing," pages 18 and 19.
‡ Address: University of Sheffield, Sheffield, England.

THE USE OF ENGRAVING MACHINERY*

By C. H. COPPACK†

Having seen some articles in MACHINERY on special work done on the Gorton engraving machine, the writer thought that a description of the uses to which the machine made by Taylor, Taylor & Hobson, Ltd., of Leicester and London, can be put, would be of interest. This machine was originally made for engraving photographic mounts with the maker's name, which formerly had to be done by rolling before lacquering. With this machine, the work can be done after all surfaces are lacquered, as no burr is raised by the engraving process. The machine was so much in demand that it was re-designed after a few years, making it available for a wider range of work.

The principle of operation is that of the pantograph with sliding adjustments for varying the size of the letters or designs made from the copies. The copies must be at least three times the size of the work to be produced, and are in one plane only. The varying depths are obtained by a hand feed through a screw. The variety of work which has been done on this machine is very great. Letters may be cut varying in height from 0.002 inch to 3 inches. Twenty letters have been cut on the head of an ordinary brass pin in one line. The machine has also proved useful in making models. Enlarged copies of the parts are made on a drawing, say ten times the actual size, and then transparent celluloid about 0.020 inch thick is placed over the drawing and the outline scribed on this. The celluloid is then cut out, both a male and female model being thus obtained. This is especially useful when making press tools. Numerous punches and dies have been made on this type of machine. The dies and punches are left with about 0.005 inch of metal for hand finishing.

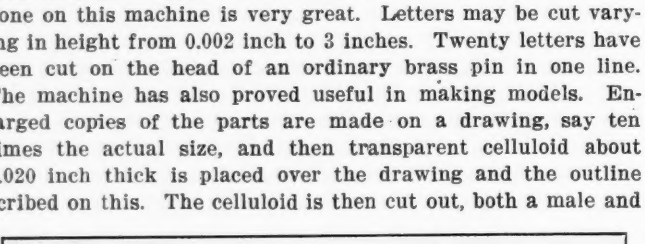


Fig. 4. Additional Examples of Work done in Engraving Machine

In instrument work, when about one hundred pieces are sometimes required, it would not pay to make press tools, especially if the piece were at all irregular. In this case the machine proves especially advantageous, as the pieces may be turned out at a cost of perhaps only one-half that of the press tools. One example of work done by this machine is that of the type wheels used in time recorders, where one wheel has twelve numbers and another sixty. Of course by means of die-casting processes, these wheels can be made cheaper in quantities, although the dies are expensive, but the metal of die-castings does not stand a great deal of wear; even brass types wear considerably in the course of time, and the best results are obtained with machine steel, casehardened. The cost of cutting the pair of wheels for the time recorder shown in Fig. 2 is about 84 cents, the time required being four and one-half hours, and the work being done by a girl.

Another interesting piece of work done on this machine is the cutting of sets of steel wheels as shown in Fig. 1, having ratchet teeth on the sides and figures on the rims. The ratchets are cut solid with the wheel. The ratchet spaces are recessed as indicated, so that a square-ended pawl can be used. The teeth are cut within a limit of 0.001 inch, and opposite teeth are tried across the center with a special gage. The figures are cut in exact relation to the ratchet teeth so that when a dozen of these wheels are put together, they will print a row of figures in a perfectly straight line. This would have been a very difficult matter to accomplish if the ratchet had been riveted to the rim, as it would then have been difficult to obtain the same accuracy.

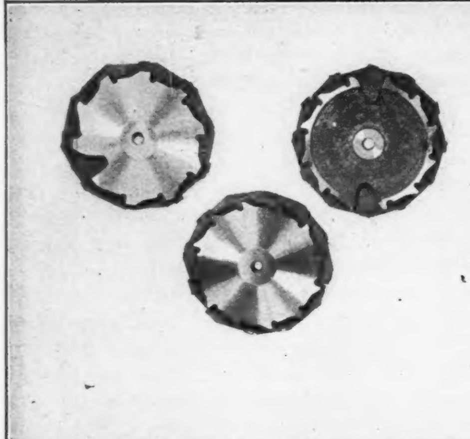


Fig. 1. Steel Wheels, with both Ratchet Teeth and Figures on Rim, cut in Engraving Machine

Fig. 2. Time Recorder Wheels cut by Engraving Machine in Four and One-half Hours

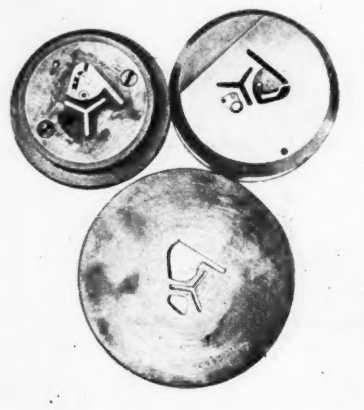


Fig. 3. Punch, Die and Stripper cut in Engraving Machine

In Fig. 3 is shown an example of punch and die work done on the engraving machine, the illustration showing a punch, die, and stripper. The punch is cut to a depth of 0.300 inch with a cutter of 0.050 inch diameter. The die is cut to a depth of 0.200 inch with the same cutter, leaving in each case 0.003 inch for finishing. Both punch and die are made of tool steel. The stripper is made of cast iron, ¼ inch thick, and is finished complete on the engraving machine.

In Fig. 4 (center) is shown an embossing punch, cut ⅛ inch deep, the corners being finished with a cutter 0.005 inch in diameter. At the left in the same illustration is shown a small wheel with figures, which was cut in fourteen minutes in lots of two hundred.

* * *

A new industrial school, combining, it appears, certain features of the trade school and high school in one, has recently been opened in Vienna, Austria. The school is claimed to be the largest educational structure in the world, and practically all trades are taught. The building has a capacity for 5200 students, simultaneously instructed, and 337 separate study-rooms are provided, making the average number of pupils per room and teacher not more than between fifteen and sixteen. The building has five complete stories besides basement, and is built so as to entirely enclose a court yard. The total length of the building is about 425 feet, and the total width about 250 feet. In addition to the square building surrounding the court-yard, two buildings connect the long side wings, thereby forming three separate courts. Besides the study-rooms for the education in the trades, considerable space is set aside for gymnasiums, recreation rooms, a restaurant where the students can obtain meals at cost, etc.

* * *

The famous 1400-H. P. Corliss engine which operated the machinery at the Philadelphia Centennial in 1876 and which subsequently was used to operate the plant of the Pullman Palace Car Co., in Chicago, was recently dismantled and sold for scrap iron.

* The following articles on this and kindred subjects have previously been published in MACHINERY: "Brass Engraving, by Machinery," April, 1912; "Engraving Calibrated Circular Scales," and "Equipment for Engraving Pearl Revolver Handles," April, 1911; "Gorton Special Engraving Machine," March, 1911; "Die Sinking and Engraving Machines," May, 1908, engineering edition.

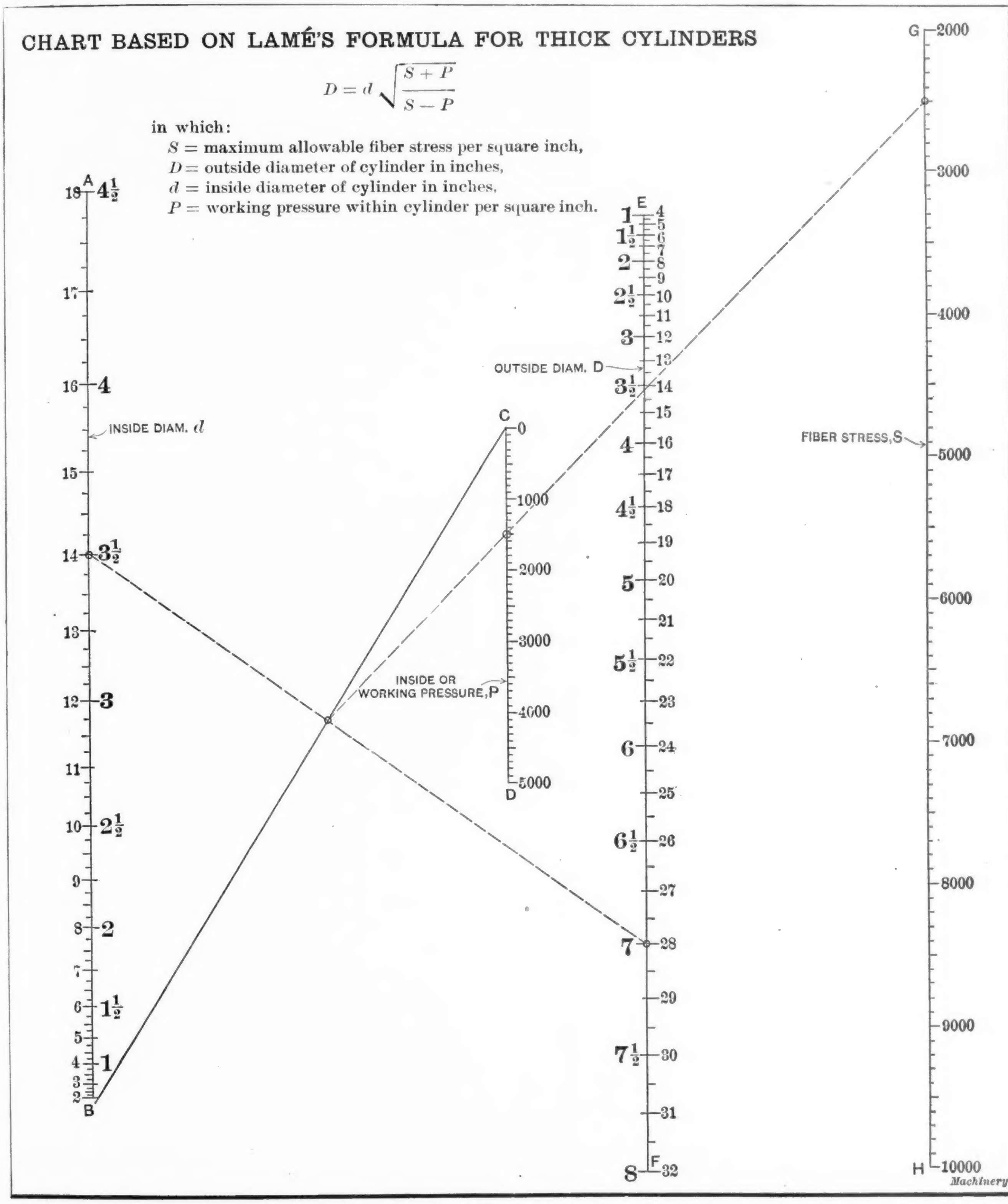
† Address: 4 Gotha St., Leicester, England.

CHART FOR THICK CYLINDERS*

By JOHN B. PEDDLE†

The accompanying chart for the rapid determination of the dimensions of thick cylinders is based on Lamé's well-known formula. This chart makes it possible to find the outside diameter of the cylinder very quickly when the fiber stress, the working pressure, and the inside diameter are known. Of course, the chart can also be used to find any other of the four quantities when three of them are known. The method of using the chart is as follows:

Locate the fiber stress on line *GH* and the working pressure within the cylinder on line *CD;* draw a line through the two points thus located, and extend this line until it intersects the auxiliary line or axis *BC;* through the point of intersection with this line draw a line which passes through the dimension for the inside diameter of the cylinder as found on scale *AB*, extending this line until it intersects scale *EF*. The point of intersection with line *EF* gives the required outside diameter. It will be seen that the scales *AB* and *EF* are provided with a double set of figures. When using these scales, the heavy-faced figures on *AB* should be used in connection with the heavy-faced figures on *EF*, the same rule being followed with regard to the light-faced figures.



An example of the use of the chart is indicated by the dotted lines. Assume that the allowable fiber stress per square inch is 2500 pounds. The working pressure within the cylinder is 1500 pounds per square inch, and the inside diameter is 14 inches. By following the directions given, we find that the outside diameter should be 28 inches; or, if the inside diameter were 3½ inches, as given by the heavy-faced figures, then the outside diameter would be 7 inches.

* See MACHINERY, July, 1909, engineering edition, "Thick Cylinders," and the articles there referred to. See also MACHINERY'S Reference Book No. 17, "Strength of Cylinders," and MACHINERY'S Data Sheet Book No. 17, page 35, "Ratio of Outside Radius to Inside Radius of Thick Cylinders."

† Address: Rose Polytechnic Institute, Terre Haute, Ind.

ANCIENT PISTOL AND SOME OLD TOOLS FROM A NEW ENGLAND SHOP

By F. R. HUMPHREY*

About 1850, one of the most progressive concerns in this country was the Robbins & Lawrence Co., of Windsor, Vt. This company had a good reputation and was well known everywhere, and a machinist who had served his apprenticeship there had no trouble in commanding the highest wages in any machine shop in the country. In many ways this company was far ahead of its competitors. An old gentleman who had served his apprenticeship in this shop claimed that the equipment of jigs and fixtures at that time was twenty years

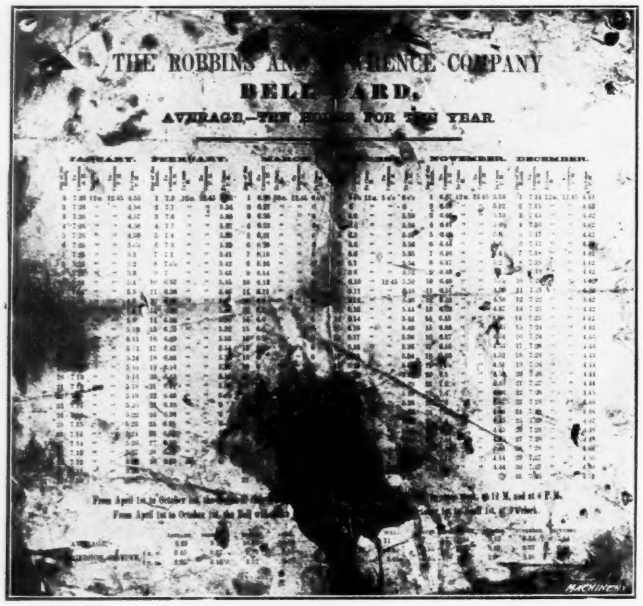

THE ROBBINS AN[illegible]ENCE COMPANY
BELL [illegible]ARD,
AVERAGE,—[illegible] FOR [illegible] YEAR

Fig. 1. A "Bell-card" of the Robbins & Lawrence Co., Windsor, Vt., in use about 1850

ahead of that of any firm manufacturing a similar line of work.

In Fig. 1 is shown a reproduction of the "bell card" which was used about 1850. The card from which the photograph was taken has apparently seen some hard usage; the dark stains covering it represent tobacco juice. This card gave the time when the factory bell—still in place on the old shop—would ring each day of the year. The time varied a few minutes each day, and was so arranged that the working hours of the shop averaged ten hours for the whole year, while at the same time the use of artificial light was avoided. During the month of December the average working time was only 7 hours and 54 minutes, while during the months of May, June, July and August, the men worked 11 hours a day.

Fig. 2. An Old Pistol made by the Lawrence & Robbins Co., patented 1849

Fig. 2 illustrates a five-barreled "hammerless" revolver which was patented in 1849. This old weapon shows, in many of its details, indications of the skill of the mechanics working with the poor facilities of that time. The revolver is of 0.28 caliber. The forward part of the barrels, shown at *A* in Fig. 3, is rifled, and the rear part, shown at *B*, is chambered for the powder and ball. Percussion caps were used to cause the explosion of the powder. At *F* are shown the vents through which the gases and smoke from the caps escaped. At *C* is shown a part of the frame which is made from a steel casting, and evidently machined by the use of jigs and fixtures. The grips at *E* are made of fine selected black walnut. The chambers, the plate and the frame are ornamented with scroll design which was hand engraved.

The hammer shown at *A* in Fig. 4 struck each cap in succession. It was milled in such a manner that it would re-

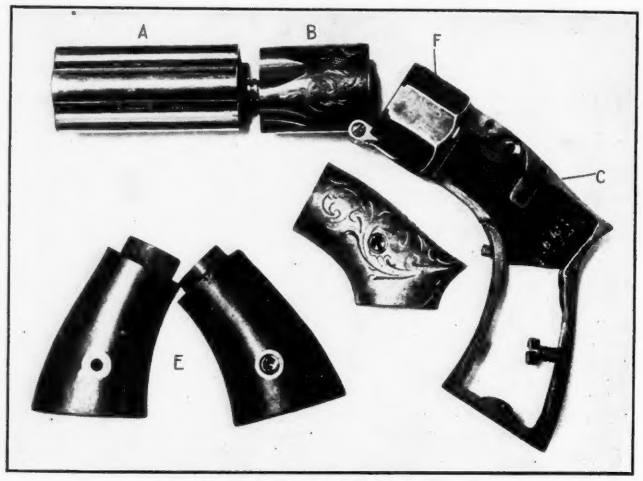


Fig. 3. Main Parts of Pistol in Fig. 2

volve one-fifth revolution while being drawn back or set, and it traveled straight ahead when released. It was milled with a combination of straight and spiral grooves, so as to be able to move in the manner indicated. The nut *H* fits on the hammer. The triggers, of which there are two, are shown at *B*. They are so arranged that by pulling back the ring *K* the hammer is set; then, by a slight pressure on the small trigger

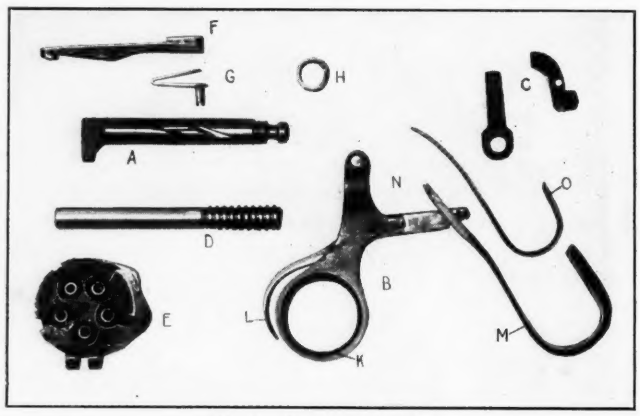


Fig. 4 Details of Pistol

L, the spring *M* is released, and the hammer is driven forward. The trip *N* is part of the trigger *L*. The button *C* is a release which acts the same as the trip *N*. The screw *D* serves to lock the barrel in place. Spring *O* returns the trigger after firing. At *E* is shown a rear view of the chambers. This view shows the nipples for the caps and the vents through which the gases escape. At the bottom is shown the

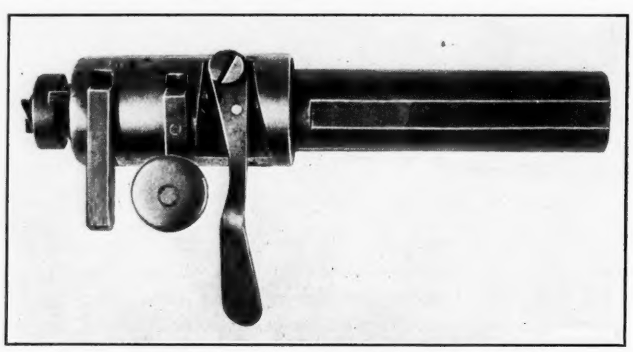


Fig. 5. An Old Hollow Mill and Threading Die with Holder

hinge. The latch *F* serves for a rear sight, and the spring at *G* holds the latch in place.

In Fig. 5 is shown a combination hollow mill and die. This unique tool was used on one of the early turret lathes. The details of the tool are shown in Fig. 6. The body *A* is made of soft steel in one piece; the hollow mill *H* is set into the

* Address: P. O. Box 585, Windsor, Vt.

spindle B and is threaded on the inside, thus forming the die. The lever C has a pin which engages in the slot J and thrusts spindle B forward in holder A. Parts E and F swivel on pin D. The thumb piece E travels in the cam slot K and forces the spindle forward; the lock F keeps the spindle from turning and catches in the notch L.

In Fig. 7 is shown a box-tool which was used on the same

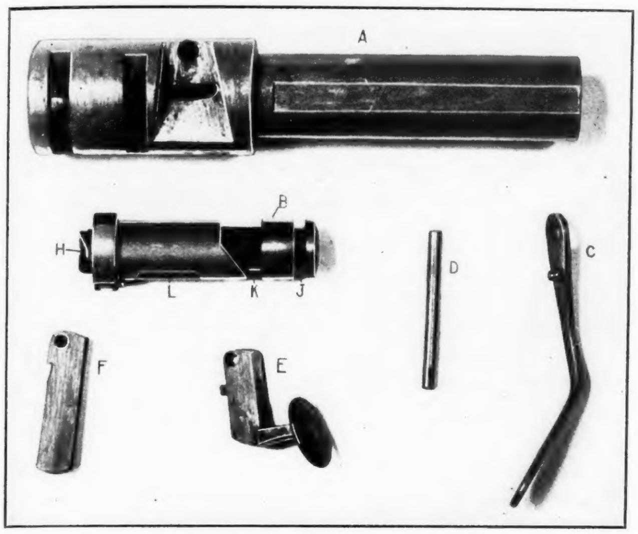


Fig. 6. Details of Tool shown in Fig. 5

machine as the former tool; the details of this tool are shown in Fig. 8. The box A is machined from a forging; parts B, C and D are bushings which are used as back-rests; C and D are held in place by the nuts E and F. The tool is provided with

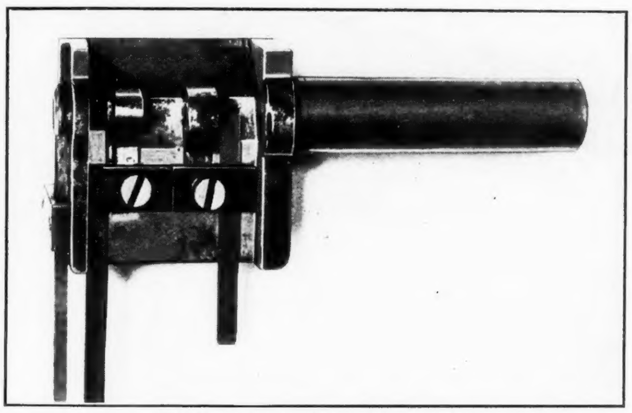


Fig. 7. A Box-tool from about 1850

two turning tools G and H, and a forming tool K. The tool G is held in place by clamp J, and the tools H and K are held by clamps L and M, and screws O and P. There are three screws N which are used for adjusting the tools relative to

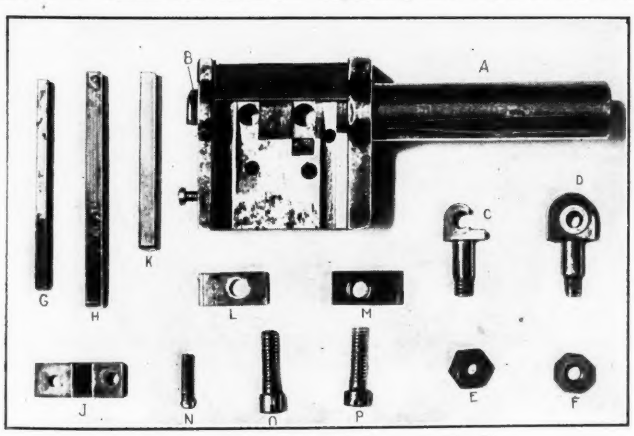


Fig. 8. Parts of Box-tool shown in Fig. 7

the center. These tools were used in the Windsor shops and happened to be left when the gun department was moved by the Winchester Arms Co. to New Haven, Conn.

* * *

A careless workman with a big monkey-wrench is expensive to have around where there are many small bolts or nuts to be tightened.

OCEAN LINERS WITH DIESEL ENGINES

It appears that the trials of the *Selandia*, a Diesel engine-driven liner, with a gross tonnage of 4900, marks a new departure in the driving of large ocean-going vessels. The East Asiatic Co., for which this vessel was built by Messrs. Burmeister & Wain, Copenhagen, Denmark, has three vessels of this type, and appears to be fully satisfied with their performance, as eight more motor-driven vessels have been ordered, two of 10,000 tons and six of 6000 tons capacity.

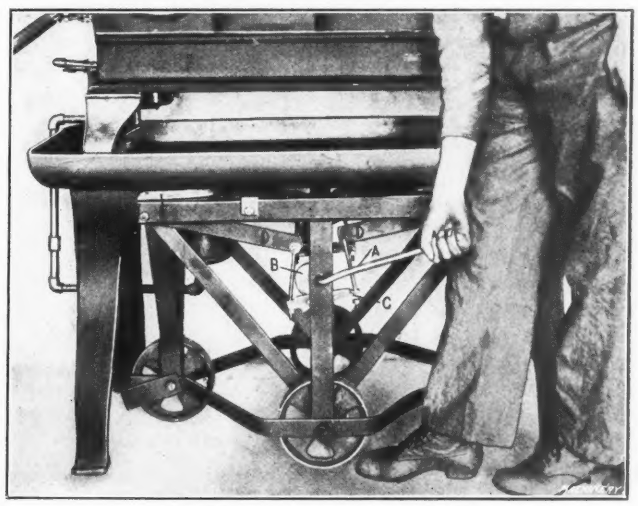
It is stated that, contrary to the expectations, there was a complete absence of vibration and noise during the trials of the vessel. In fact, even steamship engineers agreed that the machinery ran more quietly than steam-engines. The engines are under perfect control, as was proved during the trials, when the *Selandia* almost collided with another steamer, but was saved through the prompt reversing of her engines. Only fifteen to twenty seconds was necessary to change the direction of rotation from full-ahead to full-astern. On account of the absence of funnels, the vessel presents a peculiar appearance. The exhaust is led up through the hollow mizzen-mast, and the outlet is about 25 feet above the deck. The advantages gained in cargo-carrying capacity are considerable. The great bulk of the space usually given over to coal bunkers can be used for cargo. The main fuel tank of the vessel is provided for by her double bottom, which has a capacity for 900 tons of oil, sufficient to keep her main engines going during a voyage of twenty thousand miles under average condition.

The vessel is provided with twin-screws driven by two eight-cylinder engines, each developing 1250 brake horsepower (1500 indicated horsepower) at 140 R. P. M. The machinery cost about \$50,000 more than steam engines, but it is expected to save some \$40,000 a year by the use of the Diesel engines. This saving is accounted for partly by the saving on the fuel and partly by the fact that the vessel can carry 1000 tons of cargo more than a steam-driven vessel of the same capacity.

* * *

A HANDY TRUCK FOR MOVING MACHINES

The accompanying illustration shows a homemade truck, used in the shops of F. E. Wells & Son Co., Greenfield, Mass., that is extremely useful in moving or shifting the positions



A Handy Truck for Moving Machines

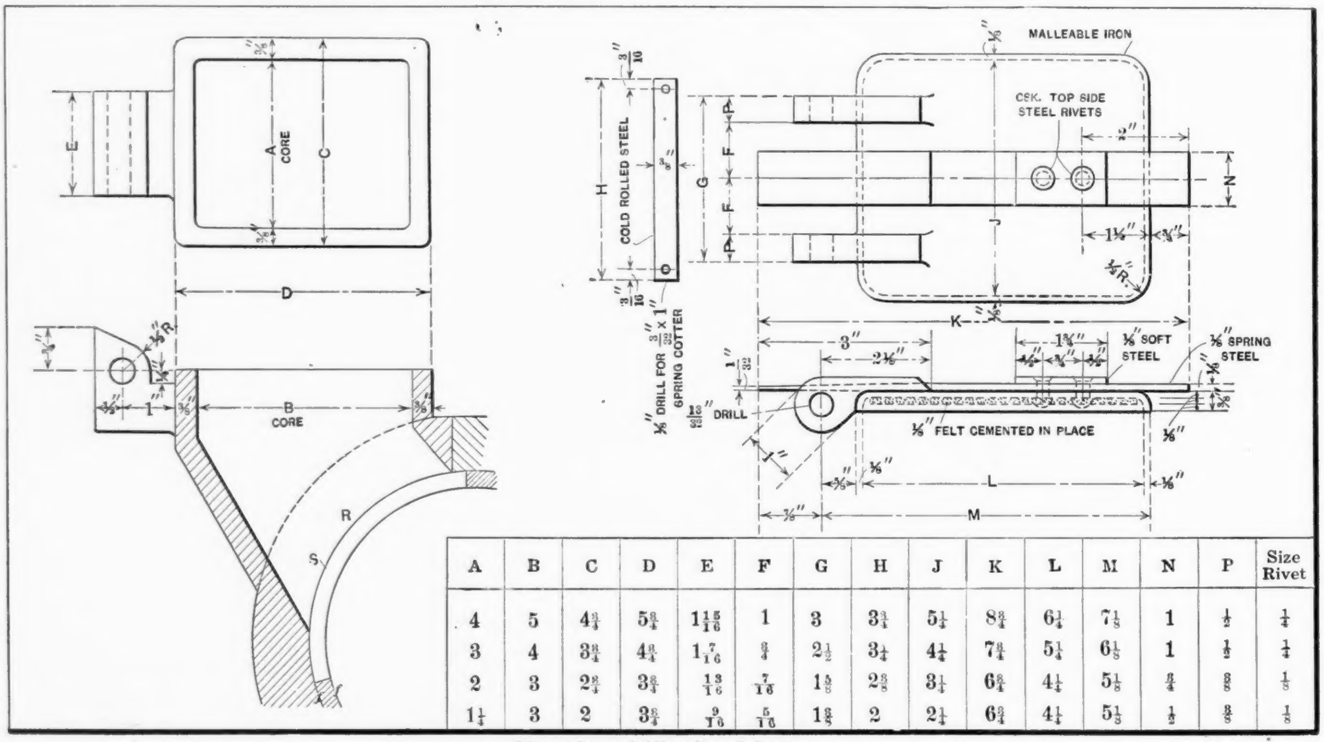
of partly erected machines. It is called the "back-saver" by the men, for it eliminates a great deal of lifting and pulling when moving a machine.

The truck is run under the body of a machine, and handle A is pulled upward. This handle terminates in the cam B, which acts against bar C and forces the bar down. This bar is attached to the inner ends of the levers D, and the motion imparted to C raises the outer ends of these levers, throwing the lifting blocks, one of which is shown at E, against the body of the machine, and thereby raising the machine enough to clear the floor. In this position the machine may be readily wheeled to the new location, and by depressing the handle, the load is dropped. The high point on cam B is slightly flattened, so that the device will remain at that position until intentionally changed.

OIL-WELL DESIGN

By F. D. BUFFUM*

The accompanying illustration shows a design of oil-wells and covers that for several years has proved to be satisfactory and superior to grease- or oil-cups. It needs less frequent attention, is easy to fill, and the oil-well cannot be lost or stolen like an oil-cup. The design is inexpensive, the lubricant is in contact with a large part of the journal, and coats it with a film much better and more evenly than a cup, and without waste. It also feeds the lubricant automatically without any adjustment. The lid and hinge boss are made similar to the Master Car Builders Association's standard used in railway service. As long as the hinge boss and the other external parts of the oil-well mouth are made of standard dimensions, the lid design and the material can be varied considerably, just as in the case of the M. C. B. journal box. No part of the passage at *R* should be smaller than the entrance, and the bushing should be cored out at *S* to correspond with the dimension *A* in the table. The dimensions given are suitable for ordinary steel or iron castings. The oil-well should be located at the top of the bearing when practicable, and should be made deep and of large capacity, the dimensions shown at *A* and *B* being the minimum dimensions.



A	B	C	D	E	F	G	H	J	K	L	M	N	P	Size Rivet
4	5	4¾	5¾	1 15/16	1	3	3¾	5¼	8¾	6¼	7⅛	1	½	¼
3	4	3¾	4¾	1 7/16	¾	2½	3¼	4¼	7¾	5¼	6⅛	1	½	¼
2	3	2¾	3¾	13/16	7/16	1⅝	2⅜	3¼	6¾	4¼	5⅛	¾	⅜	⅛
1¼	3	2	3¾	9/16	5/16	1⅜	2	2¼	6¾	4¼	5⅛	½	⅜	⅛

Dimensions of Oil-well and Cover

These oil-wells are adapted to any kind of machinery especially heavy outdoor machines where cups are liable to be stolen, jar off or break, and also to plug up with dust in summer or freeze in winter. They can be used with either grease or oil, and, with the latter, are economical of the lubricant, because it is soaked up by the wool waste with which they should be packed when oil is used. This waste then feeds the oil to the journal by capillary action, evenly and continually, and without attention for long periods of time. There is nothing to regulate or adjust, and the journal is coated with a film of oil without spilling any. The main advantage, however, is in the saving of the operator's time in attending to the lubrication. To fill, all that is necessary is to hook open the cover, pour in the oil and slam the cover down again.

The easiest thing for the designer of any machine to do is to indicate a tapped hole and call for a grease- or oil-cup where lubrication is required, and, until a few years ago, when the writer went into the operating end of the business, he supposed that it was entirely satisfactory. However, he found that it didn't take much of a machine to require half an hour or more a day attending to cups. They have to be filled when they are empty and that is not always a convenient time. Labor occupied in filling and fixing them is an expense and a delay that has to be paid for, and a small sum daily amounts to a good deal in a year.

In looking for a more satisfactory substitute, the oil-well with spring-hinged cover, used on railway motor journals for mine locomotives and for their gear cases, appeared to be just the thing. These were made in a variety of designs, but the one that seemed to be the best and cheapest was adopted and improved in minor particulars. A few were used with great satisfaction to the machine operator, and their advantages were clearly demonstrated.

These oil-wells cost no more in the end than cups, if the outlet is large and is *cored* in the lining metal and not cut out afterwards. Valuing that metal at 30 cents per pound, the opening need not be so very big to save the cost of the well and cover, and the price of the cup which is saved helps out too.

The purpose of this article and of the table submitted in connection with it is to urge that manufacturers adopt *some* standard design and thus secure the advantages of interchangeability and low cost that the master car builders' standard obtained for the railroads. There is no advantage in having a lot of different designs and sizes, such as are now in use, when the adoption of standards would cut the cost down to no more than the 25 cents, at which the M. C. B. cover retails. To have a standard, all that is required is to retain the dimensions of the hinge boss and the outside of the oil-well. The cover design can be varied to suit the designer. He can make it thicker or thinner, with felt or without, and of cast iron or other material, and still have interchangeability. For larger covers, or for hand holes, the writer would suggest the regular M. C. B. standard.

* * *

INTERESTING TEST PIECES OF MONEL METAL

At the recent motor boat show in New York some interesting test pieces of monel metal were exhibited. This metal, which has the strength of steel, takes a finish like pure nickel, and is less corrodible than bronze, was shown in the form of a 1¼-inch diameter cold-drawn rod bent over flat, surface to surface, without fracture. Another ¾-inch rod, cold-drawn, was tied in a close knot with no fracture. Other test pieces of hot-rolled rods which had shown tensile strengths of 100,000 to 103,000 pounds per square inch, with yield points ranging from 76,000 to 81,000 pounds, were to be seen.

* * *

To produce a solder that will fuse at a low temperature, add six drops of mercury to each ounce of solder. With this, soft metals melting at a low temperature, can be soldered.

* Address: Ellsworth, Pa.

THE FACTOR OF THRUSTS IN MACHINE DESIGN

By WILL O. WYNNE

The successful and effective working of many mechanisms depends entirely upon the direction of the thrusts set up in them. The question of the direction of thrusts is a phase of the designer's work which is very often left to look after itself. Negligence in this respect sometimes results in the failure of a mechanism to produce satisfactorily the desired result. When designing a new movement, a thorough analysis of all of the strains and thrusts set up will sometimes reveal the possibility of counteracting the thrust of one member by that of another, thus producing a more self-contained arrangement, and possibly reducing, to an appreciable extent, the power required for driving the mechanism.

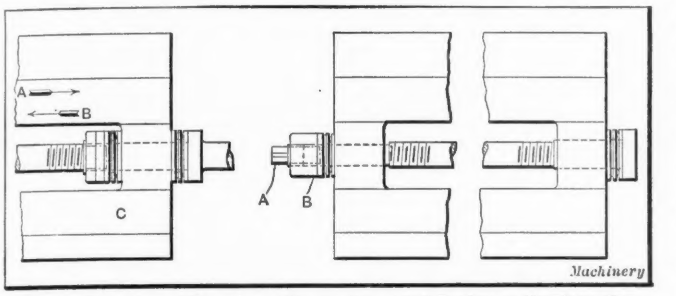


Fig. 1. Direction of Thrusts in Ordinary Carriage Construction

Fig. 2. Improved Design of Carriage Construction in which the Screw is always in Tension

Of course, there are many arrangements, theoretically incorrect, in which the thrust is not sufficient to affect the successful working of the mechanism. Such a condition of affairs is illustrated in Fig. 1. When the carriage on slide *C* is drawn, by means of the screw, in the direction of arrow *A*, the screw will be in tension, the thrust being taken by the collar on the outside of the slide *C*. When the direction is reversed, however, the carriage moving in the direction of arrow *B*, the thrust is taken on the ball washers on the inside of the slide. The screw is thus in compression. The disadvantage of this construction is not as apparent in small machines, but where heavy thrusts are set up, as in planers, it is obviously advantageous to arrange for the screw to be in tension irrespective of the direction of movement of the driven carriage. In addition to this, the construction as shown in Fig. 1 renders it rather difficult to introduce the usual form of lock-nut.

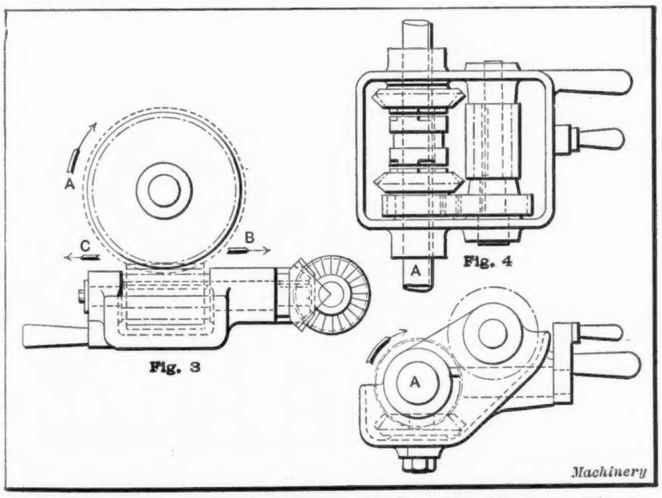


Fig. 3. Direction of Thrusts in Worm and Worm-wheel Design. Fig. 4. Worm-box with Reversing Mechanism

The arrangement by means of which the screw is always kept in tension is shown in Fig. 2, and is self-explanatory. This method allows the application of an exceedingly simple locking nut. The screw *A*, after the adjustment of the nut *B*, is forced against the end of the traversing screw; thus the thrust of the traversing screw, the adjustment of the nut *B*, and the locking of the nut by screw *A*, all act upon the same side of the thread of the traversing screw, forming a most effective lock.

In automatic trip motions, in which the feed is to be tripped while the machine is cutting, the question of direction of thrust is, in some cases, of paramount importance. This can be simply illustrated by a worm and wheel in which it is required that the box carrying the worm shall fall, throwing the worm out of gear with the worm-wheel, and thus disconnecting the feed. The worm-box, as commonly constructed, is shown in Fig. 3, and is usually pivoted at the apex of the bevel gears that impart motion to the worm-shaft. If the worm-wheel is arranged to rotate in the direction of arrow *A*, the thrust on the worm is in the direction of arrow *B*. This thrust acts on the pitch line of the worm, and the pitch line produced passes above the center of rotation of the worm-box; thus, the box is prevented from falling by the thrust of the worm. The greater the thrust on the worm, the greater also will be the tendency for the worm to be forced deeper into mesh with the wheel. If the direction of rotation is reversed, the thrust will be in the direction of arrow *C*, tending to throw the box downward, and the greater the thrust, the more effective the action when the support to the box is tripped.

An instance somewhat similar to the foregoing is that of a worm-box driven by spur-gearing, as is illustrated in Fig. 5. In this case, the box is hung on shaft *A*, which imparts motion to the worm-shaft and worm by means of spur gears *B*. If shaft *A* rotates in the direction of arrow *C*, the thrust of the spur gears on the box is in an upward direction, and this thrust will hold the box up when the support is tripped, thus necessitating some auxiliary motion to push the box out of gear. If the direction of rotation of the shaft *A* is reversed, the thrust tends to throw the box downward, and the mechanism has now all the elements of an effective automatic trip.

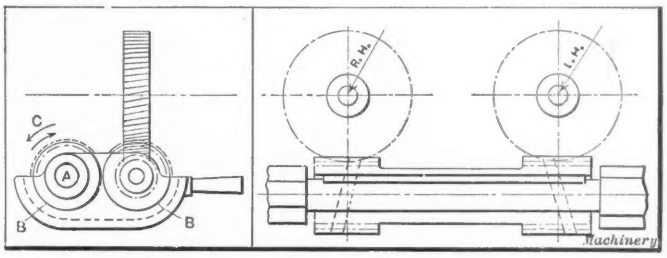


Fig. 5. Worm-box with Spur Gear Drive

Fig. 6. Twin-screw Drive in which the Thrusts are Balanced

It is very often necessary to be able to trip the worm while feeding in either direction. In this case it is advisable, if possible, to mount the reversing mechanism in the worm-box, as shown in Fig. 4. As the rotation of shaft *A* is in the direction of the arrow, the driving pressure thus always tends to throw the worm-box downward.

The consideration of the automatic balancing of thrusts has led to the design of a planer drive, as outlined in Fig. 7. This arrangement has been used by the writer for some time. The drive, as shown, illustrates a large planer table driven by a double rack. It is generally known that with this style of drive, under ordinary conditions, it is practically impossible to equally distribute the drive between the two racks. This, however, is automatically accomplished with the drive arranged as shown.

The racks *A*, of ordinary straight tooth type, are bolted to the table; bull wheels *B* mesh with the racks and ride loosely upon a large stationary shaft fixed in the bed. In mesh with the bull wheels are separate rack pinions *C*, riding loosely on a long stationary shaft *D*, carried in brackets bolted to the under side of the bed. Keyed to these rack pinions are two separate helical gears *E*, with teeth cut at opposite angles. In mesh with these two wheels is a solid double helical pinion *F* keyed to the driving shaft *G*, but free to move endwise along the shaft. The shaft *G* is driven by the usual gearing, with which we are not concerned. When shaft *G* is rotated, the double helical pinion *F* drives the helical gears *E*, which, in turn, drive the rack pinions and the racks. The pinion *F*, due to its being of a double helical form, will continually be in a state of either compression or tension; thus, if at one instant the driving pressure on one rack became greater than on the other, the difference of pressure would immediately be transmitted to the pinion *F*, causing that pinion to move endwise, and to again equalize the pressures on the two racks.

Whereas, in the usual double rack drive, great care is necessary in mounting the gears on their respective shafts in order to try to obtain an even drive, this trouble is entirely eliminated and a perfect self-contained automatically balanced drive is obtained with the arrangement above described. It will also be seen that whereas the end thrust on the pinion, whether compressive or tensile, is all self-contained, the resulting thrusts on the single helical gears are taken on ball washers mounted between the pinions *C* and the brackets carrying the shaft *D*.

The same principle might be employed in the driving of a twin-screw planer, or, in fact, in any machine which is driven by two members, one member always receiving the thrust set up by the other. The application of this drive to a twin-screw planer is shown in Fig. 8. A short article bearing somewhat upon this subject appeared in MACHINERY, August,

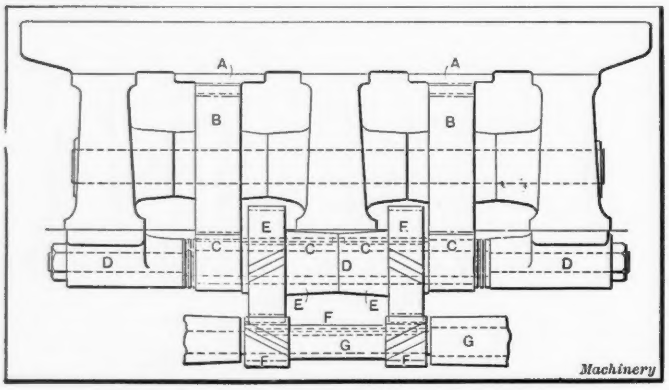


Fig. 7. Improved Form of Double Rack Planer Drive

1911, engineering edition, on page 943: "Points in the Design of a Power Elevating Cross-rail." While nothing whatever can be urged against the principle advocated in the raising and lowering of the cross-rail by means of which the thrusts are regularly balanced, using right- and left-hand screws, the construction, however, due to the possibility of automatic balancing, could be considerably improved in that the coupling for maintaining alignment could be eliminated.

After the alignment of the cross-rail has been obtained, the shaft carrying the worms can be rotated and moved endwise until the worms bear equally on both wheels, this position of the shaft then being fixed by means of a collar on each side of the central bracket, care being taken to have sufficient clearance between the worms and their brackets, as shown in the drawing. This construction, however, might fail to appeal to those who place little reliance upon a long shaft of small diameter under compression—among whom may be numbered

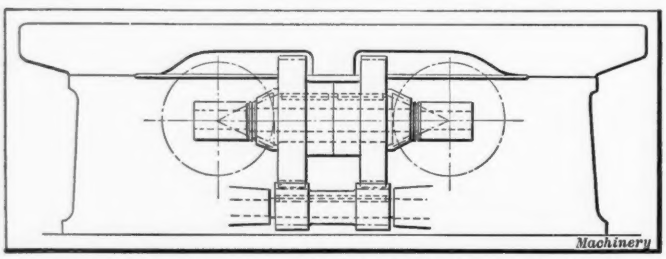


Fig. 8. Twin-screw Planer with Drive having Thrusts Equalized

the writer—although he is well aware that the shaft could be arranged to be in compression when lowering the slide.

This principle could be, and is, in fact, used advantageously under such conditions as shown in Fig. 6, in which the worms are solid with a tube that is free to move endwise along the driving shaft. This principle is the subject of several patents, but a little consideration will reveal the fact that this arrangement is by no means perfect. Similar examples could be cited and others will occur to all who are connected with machine designing, but enough has been said to illustrate the advisability of a little more consideration of a subject which is sometimes the sole basis of a satisfactory mechanism.

* * *

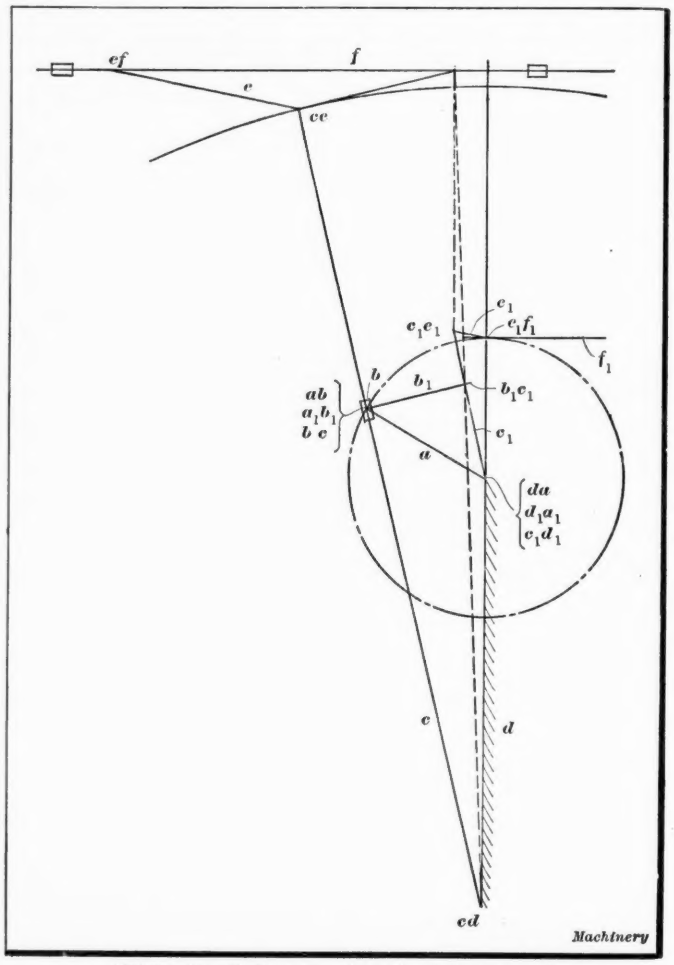
Saving a dollar in wages or in factory costs, and losing two in efficiency, is really not a money-making proposition, although lots of people seem to think it is.

THE PHOROGRAPH—A REJOINDER TO A CRITICISM

By FREDERICK H. MOODY*

In the criticism appearing in the February number, relative to the writer's article "The Phorograph," published last October, Mr. Sullivan is evidently laboring under a misapprehension of the possibilities of the phorograph system of analyzing mechanisms. Those who have used it are certain that if it had been given a fair trial on the drawing board, in comparison with the "instantaneous center" method, the criticisms offered would never have been made. The opinion of several users of the system is that there is no comparison in the simplification of the analytical work resulting from it.

In the original article, mention was made that the phorograph formed part of the instruction in the mechanical engineering course at the University of Toronto. In the early stages, the instantaneous center method is still employed, for it seems as if that method could not be improved upon from an instructional standpoint, as all the principles are presented



Quick-return Motion as analyzed by the Phorograph

in such a clear and logical manner that the relative movements of the parts are more readily understood by the student. However, this method has decided limitations in practice. For example, consider the difficulties of solving a problem by the instantaneous center method for a link attached at its ends to nearly parallel links; the instantaneous centers would be away off the board somewhere in space, making such a solution impracticable. It also requires a great deal more line drawing than the phorograph method. In the latter method, the area over which the operations are carried, so to speak, is kept within smaller compass. In consequence, while the fundamentals are taught by the instantaneous center method, that method is superseded by the phorograph in the later stages of the course.

Consider next some of the specific criticisms. The statement is made in the criticism that "the results are all correct except that in the quick-return motion illustrated, the velocity of the oscillating arm is represented by the line c_1d_1–c_1e_1, and it still remains to solve for the velocity of the ram in order to com-

* Address: 70 Bond St., Toronto, Canada.

plete the solution." To call this an omission rather than an error would have been more to the point. As the writer's article was merely explanatory of the phorograph, rather than an effort to thoroughly analyze specific mechanisms, it was not deemed necessary to carry the solution to a conclusion. The accompanying illustration shows the same mechanism with the addition of the ram *f*, joined to its connecting link at *ef*. Points *ce* and c_1e_1 have the same motion. As a point in link *e*, the image e_1f_1 of the point *ef*, must be somewhere along a line through c_1e_1 parallel to *e*. Likewise, as a point in ram *f*, which has a horizontal motion, the image must be in *d* produced, as only such points have a horizontal motion. Hence, the image is at the intersection of these two lines at the point e_1f_1. The ram velocity at that particular instant is thus the length c_1d_1–e_1f_1. With regard to the original statement calling the quick-return mechanism a Whitworth, the writer stands corrected.

Exception is taken by the critic to the statement that the image found by the solution outlined, is not *on* the constantly-revolving link itself, *i. e.*, in the simple four-link mechanism, the point b_1c_1 is not on *a*. Near the bottom of the second column of the original article, there is the following statement: "The link *a* is considered as a large member of sufficient size to include the images in all positions." The line shown representing the link *a* is only a skeleton line connecting centers, the actual link comparing as regards size to the disk-crank commonly found on large stationary engines. This, of course is only a constructional assumption. The scaling methods suggested by Mr. Sullivan are good, representing natural developments in any method of graphical solution.

The line of reasoning outlined by the critic in his second to last paragraph, and in the first sentence of the last paragraph, emphasizes his unfamiliarity with the subject he is criticizing. The conditions mentioned, while from a casual inspection presenting much the same appearance, are fundamentally different, and require an intelligent knowledge of the application of the phorograph to obtain the correct solution, for it will be noticed in the first instanced case that the block is sliding on the stationary link on which all points are the same, while in the second case, the block is sliding on a movable link on which all points have different relative motions. If the solution originally outlined be carefully analyzed, it will be found to be perfectly correct and logical, embodying in a simple manner the phorograph principle.

Near the end of the criticism, there is this statement: "In Fig. 4 of Mr. Moody's article, it will be found difficult to project b_1c_1–c_1d_1 to a tangent from *ce* accurately." If the original article be correctly read, it will be found that no such move is attempted. The construction that was outlined may be seen by referring to the accompanying illustration, which in this particular is the same as the one referred to. Quoting from the original article: "The distance between b_1c_1 and c_1d_1 corresponds to the distance between *bc* and *cd;* so in order to obtain the full image of the link *c*, we must join *cd* and b_1c_1, producing this line to meet a tangent from the point *ce*. From this point of intersection, drop a perpendicular to cut a line through c_1d_1 and b_1c_1 produced, in the point c_1e_1. The line between c_1d_1 and c_1e_1 is the image c_1 of the link *c*, obtained by simple proportion, this method of obtaining it being simply a constructional means of so doing." The tangent at *ce* is at right-angles to *c*—a simple construction. No difficulty should be experienced through graphical errors in the other points, as the locating points are all a good distance apart, minimizing the possibility of error.

In conclusion, the writer wishes again to emphasize the fact that if the phorograph be first properly understood, its application will lead to simplification in the solution of problems commonly solved by the method of instantaneous centers.

* * *

A small tube and bulb containing mercury and so arranged that the rise of the mercury due to its temperature closes an electric circuit and rings a bell, may be effectively used as an alarm for hot bearings. The apparatus is attached directly to the bearing, and when several bearings are connected, an ordinary electric bell indicator can be used to show which bearing is hot.

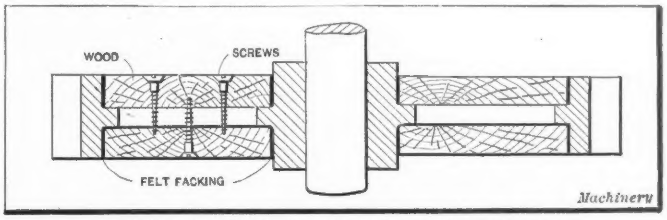
DATA ON ROPE-DRIVING

In a paper read by Mr. R. E. Hart before the Association of Engineers-in-Charge (England), the author stated in a concise manner the main requirements for a successful rope-drive. The main features of an ideal rope-drive are that the diameter of the pulleys shall not be less than thirty times the diameter of the rope used, and the driving and driven pulleys shall, if possible, be of equal diameter; but where this cannot be arranged, their ratios should not be greater than 5 to 1. The distance between the pulley faces should, if possible, be not less than 25 feet, and the drive should be horizontal, with the slack side of the rope on the top. The speed may be from 2000 feet to 4000 feet per minute. If the speed is too low the ropes are apt to slip, and if too high the action of centrifugal force affects the efficiency. There should be a distance of from 4 feet to 6 feet clearance under the ropes, and the ropes must, of course, not rub on anything. An allowance of 2 or 3 inches clearance between the bearing foundations and the sides of the pulleys must be made so as to leave room for the ropes to be put onto the pulley. The pulleys must also be accurately in line, well balanced, and the grooves exactly alike. All gears between the prime mover and the rope-drive should, if possible, be avoided; the ropes should be kept dry, properly lubricated, and not too tight. They should all be put on at one time, and the full load should be applied to them as soon as possible after they are in place. Carrier pulleys, rollers, and angular drives should be avoided as much as possible. Regarding the two types of rope generally used—namely, three-strand and four-strand—the former can be made more pliable than the latter, and it is also stronger; but these advantages are more than counterbalanced in the four-strand rope, because, compared with the three-strand, it stretches very much less, and it has a larger surface in contact with the pulley grooves; it is also capable of a stronger splice. A well-made four-strand rope is, moreover, nearly as strong as a three-strand, but it requires more skill to splice it. The general opinion now is that cotton is the best material to use for driving-ropes, and Egyptian cotton, though a little more expensive than American, is generally preferred.

* * *

A CURE FOR NOISY GEARING

A little kink for eliminating the noise of gearing is given in the *Practical Engineer* (London). Trouble was experienced from the excessive noise made by the gearing of a crane placed in such a position that the noise was highly objectionable. Several methods were tried to eliminate it. Grease and oils of all kinds were used with but temporary success. Finally the following method was tried: The annular space between



A Method for Eliminating the Noise in Crane Gearing

the hub and the rim was packed with wood. This wood butted tightly up against felt pads as shown in the engraving. The pieces of wood were secured to each other by ordinary wood screws, care being taken not to have the heads project. Good hardwood should be used, and rubber might be used to advantage instead of felt, except for exposed outdoor work. This method eliminated the objectionable noise from the gearing.

* * *

In a report by the secretary of the French Aero Club, relating to aviation in France during 1911, the following figures indicating the development of aeronautics are given. In that country alone 13,000 flights were made across country, and in total 1,625,000 miles was covered; the total time that aeroplanes remained in the air was 30,000 hours. The English Channel has been crossed thirty-seven times. The accident record has decreased, and during the year 62,500 miles was flown for every fatal accident.

INDUSTRIAL EFFICIENCY*

The word "efficiency" has been used somewhat to excess for some time past. A great many people are writing and talking of efficiency who do not seem to have a clear conception of what that word means. It is the special business of the engineer to study efficiency, but the fact that a man styles himself an "efficiency engineer" is not necessarily a recommendation. Recently a man prominent in the industrial field stated that it seemed as if everyone who had failed at everything else was advertising himself as an efficiency engineer. Now, it is possible to be entirely in sympathy with *bona fide* efforts to increase efficiency without being in sympathy with all this talk about efficiency by people who do not know what the engineer means by this word. A society has recently been formed for the promotion of national efficiency which has spent some time trying to find a definition of the word efficiency. This being the case, there is apt to be a great deal of misunderstanding on this subject.

What we want to do is not necessarily to change our methods of work, but to do our work thoroughly, and this cannot be done by merely talking. The author's work has sometimes been criticised because it is said to have been done too thoroughly—he goes too much into detail, etc. However, any work which has anything to do with engineering must be done thoroughly.

Possibilities for Greater Industrial Efficiency

With regard to industrial efficiency, it does not seem to be necessary to present a great many ideas, but it is necessary that the fundamental ideas and causes be clear. Some time ago, the financiers of this country thought that they had solved the industrial problem by the great economies made possible by consolidation into huge combinations. Large trusts were formed, and it was believed that by eliminating competition it would be possible to manufacture and sell a great deal cheaper than had been possible in the past. These expectations, however, do not seem to have materialized, because the continually increasing cost of living in this country seems to indicate that we need something more than able financiering to round out our theory of industrial economy. This has been a growing conviction on the part of students of our economic conditions for several years, but the most critical were not prepared for the admission, before the Interstate Commerce Commission, in November, 1910, by some of the most noted railroad financiers of the country, apparently seconded by Mr. Morgan himself, that they had done everything possible to reduce the expense of operating railroads, and that from now on the public must accustom itself to increasing freight rates. These financiers thus admitted that in the branch of industry in which the financial man is, perhaps, more nearly supreme than in any other, and in which competition has been practically eliminated, rising costs forced them to ask the public to bear a portion of their burden.

The student of economics asks if there is not something lacking in our system of industrial economy that makes such requests necessary, or even possible. If it is a fact that in any branch of industry every possible economy has been effected, and that in the future costs will be higher, we are confronted with a very serious condition, the far-reaching effect of which it is hard to foresee. It has been our boast in the past that with our labor-saving machinery and our improved methods, we had so reduced costs as to make the luxuries of today the necessities of tomorrow. If, in any branch of industry, we are forced to acknowledge that costs will in the future be higher, are we not pointing to the time when these necessities will again be luxuries?

The statement, which happily few believe to be a fact, that in any industry the minimum cost has been reached, and that hereafter costs must be higher, is such a serious one, and fraught with such serious consequences to our industries at large, that many of us feel like asking the great financiers who are backing this statement to speak for themselves only, for there are many engineers who not only do not agree with them, but who believe there are means of increasing efficiencies and reducing costs that the financier has as yet no conception of. These methods have been applied in isolated cases, and to a greater or less degree to a great variety of industries, and they have produced a better and a cheaper product; and the workers are better paid and better satisfied.

In making this statement, it is not intended to disparage the work of the financier, but to remind him that the civilization of to-day has not been built up solely by his efforts. In this process, the engineer and his able assistant, the skilled mechanic, have been even more integral factors than the financier, and until they hold up their hands and say the end is reached, that modern combination of engineer and mechanic, the mechanical engineer, respectfully asks that they withhold their cry of despair, and allow him to present what Mr. Brandeis calls his "Gospel of Hope."

Present Tendencies in the Development of Industries

Until within a few years, all mechanical knowledge was empirical. It had been gathered by cut-and-try methods through centuries, and was handed down with no written record. Yet, it is wonderful what great progress had been made. The master workman of a century ago was justly proud of his work and of the apprentices that went forth from his shop. With the perfection of the steam engine, which is the foundation on which our civilization is built, and which was the invention of a mechanic whose work has had a greater influence on the world than that of all the financiers that ever lived—with the perfection of the steam engine, the master workman obtained cheap power, and was enabled to increase the size of his shop. The increase in size of the workman's shop gradually developed the factory system of today, in which the foreman and workmen have no interest other than their daily wage, and where they are too often laid off without cause and without notice, to suit the plans of the owner. Is it surprising that, under these conditions, their interest in the training of apprentices should lag, and that the foremen and workmen should take but little trouble to train men who will shortly become their competitors?

The Use of Records

But this is not all. The owner too often puts all responsibility for the promotion of efficiency upon his superintendent and foremen, yet limits them in the wages they are allowed to pay, or the records they are allowed to keep. The records, as a rule, are just sufficient for him to make criticisms by, but not enough detailed to enable the foreman or superintendent to know where the inefficiencies are, or which of his men are most valuable to him. In one concern a man who had complete charge of all the cost records frankly avowed that he was not keeping these records for the benefit of the superintendent; he was simply keeping them so that he would know what was being done; he did not care anything about the superintendent. In other words, he was there to criticise, not to help. He had a lot of clerks to help him do the work. Now, he did not say so, but this is what was in his mind: Those records were to keep somebody from stealing something. In fact, there are too many records to keep somebody from stealing something, and not enough to help the man who has to do the work to do it right. The difficulty of keeping people from stealing things is not great; we do not have any difficulty in that. The records of cost and material should be kept to enable people to do the work right.

Having no individual record of his men, the financial head too often orders that all men of a certain class shall be paid the same wage, and for a long time it has been extremely difficult for the capable man to rise much above his fellows, no matter how much more, or better, work he did. What has been the result? The capable man, failing to rise above his class, has devoted his energy to raising his class, and by means of his union has forced his employer to raise the class wage, regardless of the work that was done. But let us not blame the financier or the owner too much for that. When he allowed his foreman or, perhaps, his superintendent to raise wages, he found that very often the brother-in-law, or the nephew, or somebody like that, got the high wages and the efficient man did not, and that has happened too often. When he found that out he said, "Well, we will pay machinists all the same wage." But when he made that statement, he put the strongest possible weapon into the hands of the men who wanted a

* Abstract of an address by Mr. H. L. Gantt before the American Society of Swedish Engineers, Brooklyn, N. Y., March 23, 1912.

union. They then said, "If we cannot get increased wages for the efficient man individually, we will get higher wages for our whole class," and they then banded together to get the union wages, and you cannot blame them.

The employer now complains bitterly; but has he not combined with his fellow to get all he could for what he had to sell? Are the workmen not playing the same game he has played, and playing it better? By forcing the capable man to remain in his class, the employer has held back the individual, but greatly strengthened the class, until today the employer with his combination on one side, and the workman with his union on the other, stand facing each other as two great armies, each trying to get the better of each other, by manoeuvering, if possible, but by fighting, if necessary. Without considering who is to blame for this condition, let us ask if there is any remedy.

The Causes of Industrial Unrest

While arbitration has certainly averted strikes, it has not settled anything, or diminished the desire of either party to oppose the other, and can only be considered as a temporary expedient. Collective bargaining has certainly increased the wages of the workman, but cannot alone offer a final solution of the labor problem, for wages cannot be increased indefinitely. The railroad presidents claim that the increase of wages obtained by this means necessitates increased freight rates, which, if granted, must necessarily, in a measure at least, increase the cost of living. Thus, neither arbitration nor collective bargaining, on which we have placed so much confidence in the past, gives promise of any permanent solution of our difficulties, and the time seems rapidly approaching when the friction of conflicting interests will seriously hamper our further development. We, therefore, naturally, ask why these interests conflict. The answer is plain; neither party has been willing to consider the interest of the other. The employer has too often insisted on paying the lowest wage, regardless of the service rendered, while the employe, through his union, has demanded the highest wage, regardless of what he gave in return.

I heard something in the last two or three days that quite astonished me. I have heard the same thing from three or four persons, but the last time I heard it from a rather unexpected source. I have heard a number of men make the statement recently that the financier—the capitalist—was getting too large a percentage of the earnings of the increase in wealth. A man told me that a millionaire friend of his in Wall Street had made that statement to him. Now, there is not any question that within the last fifteen years there has been a much greater percentage of the increased wealth harvested by those who already had wealth. The worker, the engineer, the producer, did not get the same proportion of it that he had gotten previously, and that is one of our troubles today. The very serious unrest in this country, England and the countries of Europe, is due to the fact that the workmen have made up their minds that they are going to get a larger percentage. Now, we have got to face that condition and find out what is the proper thing to do, and try to do it as soon as we can, and prevent what seems to be the impending conflict, which is due to the fact that both employer and employe have disregarded the great principle of equity, which is the foundation of all harmony.

In the commercial world it has long been recognized that transactions which do most to promote prosperity are those which are beneficial alike to buyer and seller. Does not the same law hold good in the industrial world in the purchase of labor? With the operation of such a law, the interests of the employer and employe become identical, and we have laid the foundation for their harmonious cooperation. Having done this, we are ready for the next step, namely, the promotion of efficiency in the utilization of human effort. The progress so far made in this direction has in many cases been in spite of a lack of equity in the relations between the employers and employes. Consider how much faster progress could be made if all men were assured of an equitable return for their efforts.

As a matter of fact, real efficiency is impossible without equity, for no man will continue to put forth his best efforts without a proper reward. The idea of doing work efficiently is comparatively new to people in general. It is only within very modern times that the best educated people have given any thought at all to the subject of physical work. The only serious subject requiring manual skill that was considered worthy of their attention was that of fighting, or war. As a matter of fact, it was Sir Henry Bessemer's search for a stronger metal with which to make field guns that gave us Bessemer steel. Until within a few generations, it has been very much more important to defend the wealth you had than to acquire more than sufficed for your daily needs. Hence the importance of defence. The time has come, however, when a man no longer has to defend his property with his skill or life, and can devote his energies to acquiring a surplus for himself and family. The great majority of men are ambitious to secure such a surplus, and are willing to work efficiently and industriously if they can be assured of an equitable compensation. The precise method of compensation is comparatively immaterial, provided efficiency is rewarded and not penalized, as is too often the case.

What has become of the ingenious Yankee, of whom we heard so much forty years ago? Are Yankees less ingenious today? Not at all; but our factory system of today too often fails to reward either ingenuity or efficiency, and these men have turned their attention to getting their advancement through their labor union. How much better it would be for the community at large if these men could devote their labors to the promotion of efficiency, and thus get their reward. A system of industrial economy based on industrial warfare is so evidently wrong that few will undertake to defend it, for it necessarily groups employers and employes into two hostile camps. Under such conditions, cooperation within each class is to be expected, and the combination of employers on the one hand and the formation of labor unions on the other are the only natural results.

Now, it seems that these segregations of interest which are practically mutual in their nature, are the cause of a great deal of our industrial difficulties. It is not out of place to dwell so long on the industrial unrest, because the great problem before us today, industrially, is the very problem outlined in the foregoing paragraphs. It is necessary to utilize the human efficiency in such a way that all the reward of the increased efficiency does not go to one class. The man who works wants his share, and it is, therefore, necessary to devise ways and means to give him a larger proportion of the results of his labor. Any scheme for the utilization of the energies of the community for the benefit of one class of people only, would develop an oligarchy which would ultimately be overturned by a revolution. England presents an example of the conditions that follow improper economic relations. It is felt in England that even though the coal strike be settled, they have not passed their worst danger. There is an industrial unrest there of which the coal strike is merely a symptom, and the whole country is stirred up a great deal more than is indicated by that strike.

The Task Idea

In trying to find a means for uniting the interests of the employer and employe, the task idea was developed; that is, the idea of putting before each workman a certain task to be performed in a given time, assuring him his regular wages if he could not perform the given task, and promising him a suitable reward in case he was able to perform the given task in the given time.* One of the important points relative to this method, frequently called "scientific management," is that the reward or bonus must be great enough so that the workman will feel that he is fully compensated for the extra exertion required to do the task. The bonus is usually from 20 to 50 per cent of the regular day rate. Task work does not necessarily mean more severe work, but it means more continuous work, but at the same time, work under more favorable conditions.

Another important point that should always be noted is that having set a task, the responsibility for its performance does

* The subject of task work and the methods employed were dealt with in the December, 1911, number of MACHINERY, in an abstract of a paper entitled, "Task Work—The Basis of Proper Management" read by Mr. H. L. Gantt before the National Machine Tool Builders' Association.

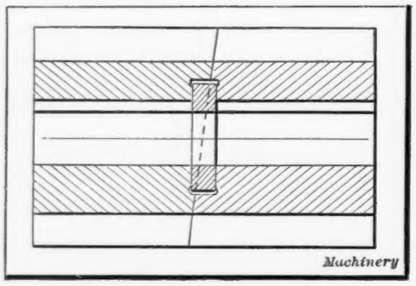
not rest upon the workman alone. Every case of lost bonus must be investigated by the management, and the reason determined. It seems very difficult to get people to grasp that idea and to go to that trouble. If a man does not make the bonus, they seem perfectly willing and content to let him lose it and pay little attention to him, but this is a great mistake and tends to discredit the system. The man is discouraged—it may not have been his fault; the machinery may have been out of order or the appliances he has been working with may have been unsuitable; the material may have been inferior in quality. All these reasons may have prevented him from performing his task. Frequently imperfections and defects in material bought have been found simply by investigating why the workman has been unable to perform his task; yet, that material may have passed inspection, but the imperfections have been such that they could not be located in that manner, although they would show up when the workman got ready to perform his work.

If, again, when some workman is unable to accomplish his task, a capable man, in whom he has confidence, tries to find out what the reason is, he will feel satisfied and try to earn his bonus the next day. Therefore, in the task system, next to the subject of the proper task comes the necessity of investigating every case of lost bonus and of determining the reason. If a proper scheme of management is devised, by which all the available knowledge is used to plan the work, and if the tasks are set in accordance, and the workman liberally compensated for the performance of the task, there is no question but that marked economy can be produced by this new method of management.

* * *

SIMPLE METHOD OF INTERLOCKING MILLING CUTTERS

The accompanying illustration shows a simple method for interlocking milling cutters. As indicated, the method consists simply in milling or planing off the ends of the two halves of the cutter at an angle, and providing recesses in the angular faces as indicated. The angular faces are not intended to bear tightly against each other, and, hence, do not need to be absolutely true, but the bearing is on a washer placed in the recess mentioned, as it is much easier to provide true bearing surfaces in that manner.



"Interlocking" Milling Cutters

The method was originated by the firm of J. A. Kühn of Frankfort a. M, Germany, and was recently described in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge.* It seems that this method has certain advantages over the ordinary interlocking methods on account of its simplicity. It may not be exactly right to call the method an interlocking one, as it is rather a case of "overlapping" milling cutters. The object in view, however, with both the interlocking method generally used in this country and the method shown in the accompanying illustration, is the same.

* * *

According to *Power*, Sir Hiram Maxim recently made a statement regarding the superiority of American workmen. It was his experience that in England, for example, while there are plenty of men to be hired at a salary of about 30 shillings ($7.50) per week, it was difficult to find a man at £5 ($25) a week for a position requiring care and intelligence. In Canada and in the United States he believed a positively different state of affairs to exist. In 1877 to 1880 he had charge of an electrical works in which a considerable number of young men were employed, and today nearly every one of them is in a high position. Young American mechanics are found studying algebra and geometry, while in England the penny novel takes the place of scientific books.

A SMALL MACHINE VISE

By CHESTER L. LUCAS*

Fig. 1 shows a small vise or clamping fixture which has proved valuable for holding miscellaneous pieces in the toolroom, as pins, screws, or small flat blocks, upon which some slight machining operation such as drilling or milling must be performed. This vise is made from a Starrett toolmaker's clamp and consists essentially of a jaw *A* which is held to the inside face of the end of the clamp by a fillister-head screw *B*. The other jaw *C* is a counterpart of the first, and, in making, the two are clamped together and holes drilled for the two dowel pins *D* which are more clearly shown in the line engraving, Fig. 2. These dowel pins are made a driving fit in

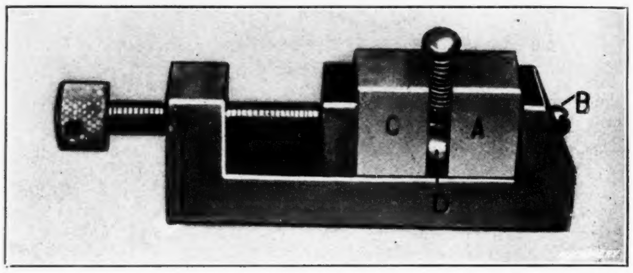


Fig. 1. Small Machine Vise, made by adding Jaws to a Toolmaker's Clamp

the holes in the movable jaw of the vise and a sliding fit in the holes in the stationary jaw. Small spiral springs placed behind these pins insure that the jaws will open when the pressure on the movable jaw is released. Two vertical V-grooves are cut in the centers of the jaws so that round or square pieces may be rigidly held in an upright position. By cutting a socket in the back side of jaw *C*, to receive the clamping screw, the flat tip shown on the screw may be dispensed with, but it works very satisfactorily as shown. The object of using the two dowel pins, which, by the way, is the important feature of the fixture, is to provide a means for holding work perfectly true, the tendency otherwise being for the inner jaw to lift the work when pressure is applied behind the

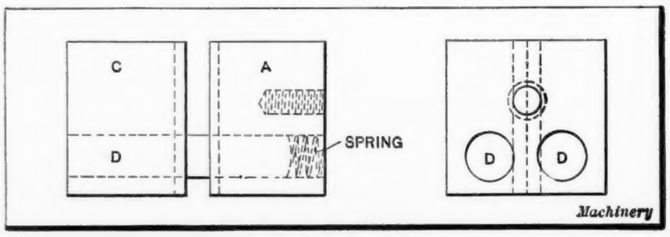


Fig. 2. Details of Jaws

jaw. With this method of guiding the jaws, no trouble is encountered from this source. For holding the clamp and jaws on the table of the milling machine, two holes may be drilled through the center of the bottom part of the clamp. These holes are countersunk from the top, and flat-head screws may be passed through and into T-nuts or blocks in the T-slot of the milling machine table. When the clamp is wanted for regular work, the fillister-head screw *B* and the jaws are removed.

* * *

The Supreme Court of the United States will not reopen the Dick mimeograph constructive patent infringement case, and the decision of March 11 stands, affirming the right of the makers of a patented machine to prescribe what supplies shall be used with it. The gravity of the situation is generally recognized and Congress should immediately pass such legislation as is required to relieve an intolerable condition. Legislation is also required that will give inventors better protection and prevent the buying up and shelving of patents by corporations seeking to monopolize any line of manufacture and selling.

* * *

At the factory of the Wells Bros. Co., Greenfield, Mass., the 300 employes who do not go home to their lunches are supplied by the firm with hot coffee, which is provided free of charge.

* Associate Editor of MACHINERY.

UNUSUAL HOBBING OPERATION

The shaft seen to the left in Fig. 1 is used in the construction of the Amplex motor cars (built by the Simplex Motor Car Co.), for advancing the spark or varying the points of ignition in the engine cylinders. As the illustration shows, this shaft has four equally spaced spiral grooves which are

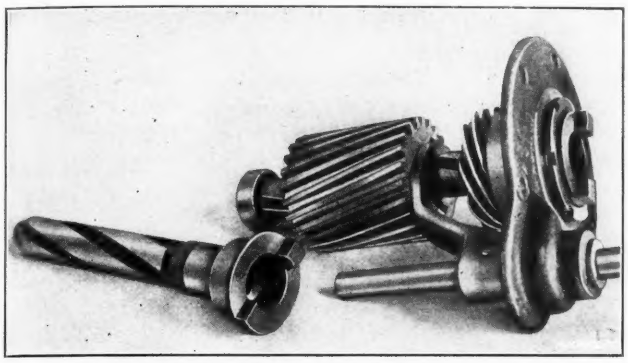


Fig. 1. Spark-advance Shaft having Helical Grooves which are cut by Hobbing—Shaft assembled with Shifting Fork and Timer Gear

¼ inch wide and ⅛ inch deep. When the shaft is assembled as shown in the view to the right, it is connected with the shifting fork and timer gear, and the right-hand end is equipped with a clutch which is coupled to the armature of the magneto. The four spiral grooves for giving this spark advance shaft a rotary movement, are cut by hobbing in a Lees-Bradner hobbing machine. The operation is both novel and interesting and presents some new features in the design and application of a hob.

The way the machine is arranged for this work is shown by the detail view, Fig. 2. The shaft is held at one end, by a draw-in collet inserted in the horizontal work-arbor, and the other end is supported by the regular tailstock center. The cutter-head containing the special hob is set at right angles to the axis of the work. This hob has four teeth, and the four helical grooves in the work are cut simultaneously. The four teeth are equally spaced and each tooth finishes its own

Fig. 2. Method of Hobbing Shaft in Lees-Bradner Hobbing Machine

groove. The hob and shaft rotate in unison, there being approximately one revolution of the cutter spindle for each revolution of the work spindle. In Fig. 2 is shown a shaft that has just been completed.

The relative action of the work and hob, as well as the construction of the latter, are shown more clearly in the diagrammatical view, Fig. 3. As previously intimated, the hob is set in a perpendicular position, the four cutters and the axis of the work all being located in the same horizontal plane, as shown in the end view. The shaft to be splined rotates in the direction indicated by arrow *w*, and the hob, as shown by arrow *h*. In addition, the shaft has a longitudinal feeding movement to the left, and a slow differential movement which determines the angle of the helical groove generated. The action of the hob and work is as follows: Cutter *A* cuts groove A_1 (see end view) and when the hob has rotated one-quarter revolution, thus bringing cutter *B* to the front, the work has also turned a corresponding amount (plus the rotation due to the differential movement), so that cutter *B* enters groove B_1. Another quarter turn brings cutter *C* into groove C_1 and in the same manner, tool *D* enters groove D_1. The differential movement previously referred to causes each cutter to follow a helical path on the work. When a cut is started at the end of the shaft, the gashes generated by the four cutters are at an angle owing to the rotation of the shaft, and in order to make the cutters follow the helical path thus started, as the work feeds longitudinally, it is necessary to have a differential movement; in other words, if a single gash were cut across the shaft, without the differential movement and with the cutter and work rotating uniformly, the angle of this gash would equal the angle obtained by the differential movement.

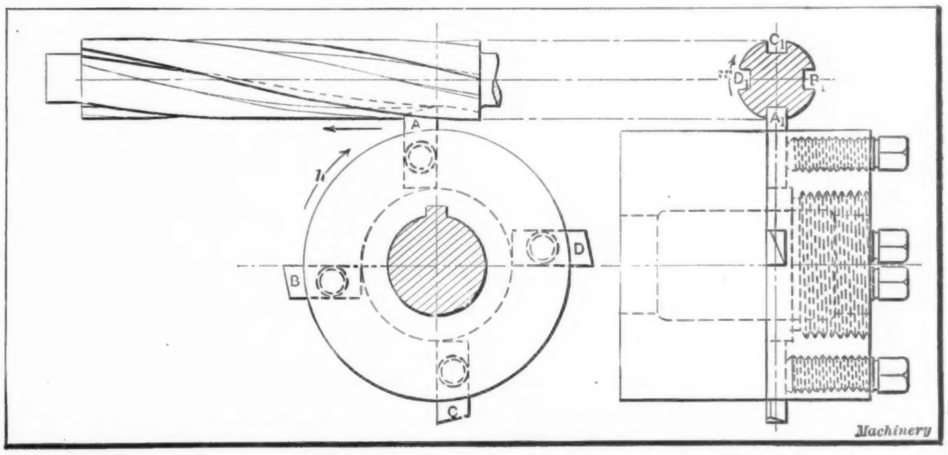


Fig. 3. Diagram showing Work and Four-toothed Hob used for Cutting the Helical Grooves

It will be seen that the hob is, practically, a four-tooth fly-cutter and each groove is milled to the proper depth by a single tool. The four grooves are finished in one passage of the work and the time required for hobbing a shaft is seven minutes. The length of the shaft is 7¾ inches, the diameter, ⅞ inch, and the material 0.020 carbon steel. The lead of the spiral is 11.568 inches and the spiral angle, 13 degrees 22 minutes. Each groove generated by this hob is similar to a

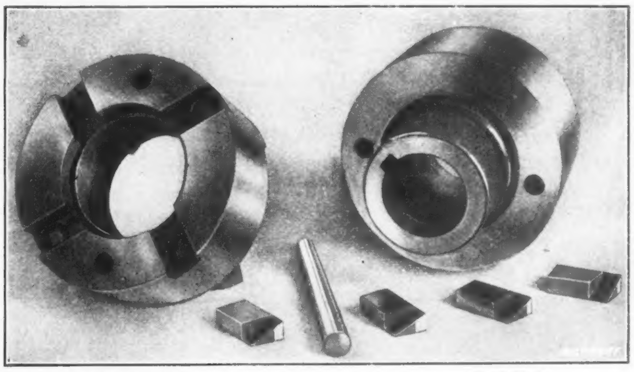


Fig. 4. The Component Parts of the Four-toothed Hob

helical keyway in that the sides on a cross-section taken at right-angles to the axis of the shaft are practically parallel to a radial line passing through the center of the groove. The groove differs in this respect from a theoretically correct thread groove, the sides of which are square on the longitudinal section.

The construction of the hob, as well as the form of the cutters, is shown in Fig. 4, which is a view of the hob before assembling. It consists of a body having a threaded hub over which is screwed the locking ring seen to the left. This ring

contains the tool slots which are ground to size and are accurately spaced equi-distant from each other, in order to secure uniform spacing of the spiral grooves on the shaft. It will be noted that these slots are offset so that the front or cutting face of each tool will be on a radial line. The cutters are made from high-speed steel and the cutter shanks are ground to fit the slots in the locking ring, so that they are interchangeable. The cutting edge is parallel to the axis of the hob and the under side of each cutter has a rather large clearance angle in order to clear the lower side of the groove. When a hob becomes dull, it is sharpened by simply grinding the tops of the teeth.

* * *

CUTTING SPEEDS AND FEEDS FOR TWIST DRILLS

The accompanying diagram originated by Messrs. E. G. Wrigley & Co., Ltd., of Birmingham, England, is published by the *Practical Engineer* (London). It gives speeds and feeds applicable to ordinary practice for high-speed and carbon steel twist drills, when drilling mild steel. As the values given

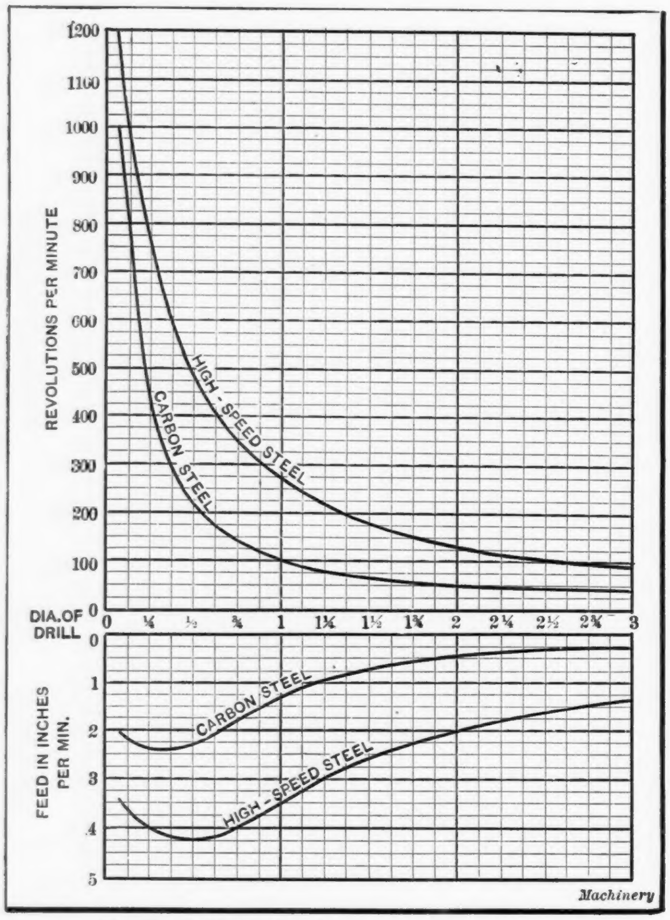


Diagram of Cutting Speeds and Feeds for Twist Drills

are not experimental or test rates, but intended for everyday practice, they may, of course, be exceeded under favorable conditions. It is, however, generally desirable to keep the cutting speed comparatively low, so as to avoid overheating of the drill point, and consequent waste of power.

* * *

The Kempsmith Milling Machine Co., Milwaukee, Wis., caseharden the gears used in the feed boxes of the Kempsmith milling machine. The gears are packed in cast-iron boxes about 12 inches long, 8 inches wide and 6 inches deep with a German casehardening compound. The boxes are provided with a cast-iron cover having a groove for sealing. The groove is filled with clay when the cover is applied and the cover is held in place by two keys engaging lugs at the ends. When the boxes are placed in the furnace they are turned upside down, the purpose being to hold the covers more securely and prevent the gases from escaping. The covers are provided with four lugs or feet at the corners, on which the box rests, and in the reversed position the cover is not likely to work out of shape. The practice works well.

EMPLOYER'S LIABILITY AND WORKMEN'S COMPENSATION*†

Under the common law and employers' liability statutes, employers are held for the consequences of accidents to employes, only provided the employer or his supervising agent is negligent; and not even in such case if the employe has been contributorily negligent or the injury has been due to the negligence of a fellow-servant or co-employe; or in case the hazard was of such a character that it belonged to the usual risks of the occupation which it is considered the employe assumes by accepting the employment. These three defenses are known respectively as the "contributory negligence," the "fellow-servant" and the "assumption of the risk" rules.

Purpose of Workmen's Compensation Acts

The purpose in workmen's compensation acts is to cause the employe, or his dependents in event of his death, to receive compensation on a reasonable basis, without regard to fault. The Court of Appeals of New York held a law making the employer directly liable for such compensation to be unconstitutional as "taking property without due process of law," that is, in this case without the employer having contracted to pay under such circumstances and without his having been guilty of a tort, that is, a wrong which would give the employe a right to recover.

The method of avoiding the effects of this decision, by offering to employers an opportunity to come under a workmen's compensation act voluntarily, it being made advantageous for them to do so, has taken several different forms, *viz.*:

In New York the option was given to employers to whom the compensation act did not directly apply, to avail themselves of its provisions by agreement with employes. There was no special inducement to do this, however, and the rates of premium to cover the risk under the compensation act were so much higher than rates charged by the same companies to cover the risk under the common law and the employers' liability act, that virtually no employers took advantage of the privilege.

In several states—California, Illinois, Kansas, New Hampshire, and Wisconsin—compensation acts have been passed of the usual type; that is, providing for payments of a definite percentage of the wages (usually with a minimum and a maximum for a certain number of weeks, and of a definite amount based upon the weeks in event of death) for all accidents occurring while at work, without regard to fault. Under these laws it was made optional with the employer either to come under the act or not to do so; but in case he did not do so, two of the usual defenses, *viz.*: the "fellow-servant" rule and the "assumption of the risk" rule were abrogated, and in most cases the "contributory negligence" applied only to reducing the damages. In some of these states, *viz.*, Illinois and Kansas, if the employes refuse to be under the compensation act, these defenses are available against him and his dependents.

In three states, Massachusetts, Ohio, and Michigan, laws have been passed offering to employers the election to insure their employes so as to provide compensation to them and their dependents for the consequences of all accidents occurring while at work, without regard to fault. In these states, also, in case the employer does not so elect, the defenses of the "fellow-servant" and "assumption of the risk" rules have been taken away, and also the defense of "contributory negligence," except that in Ohio and Michigan it may be used to reduce the amount of the verdict.

Respects in which Laws Differ

In other respects, the laws in regard to insurance in these three states differ very considerably. Thus in Ohio the insurance must be in a state insurance fund, charging premiums fixed by a board, with the privilege of assessing for more;

* Abstract of a paper read by Mr. Miles M. Dawson, attorney-at-law and consulting actuary, before the fourteenth annual convention of the National Metal Trades Association, New York City, April 11, 1912.

† For a list of articles on industrial accidents and employers' liability, which have previously been published in MACHINERY, see the note accompanying the article published in the November, 1911, number, entitled "The Prevention of Industrial Accidents."

and, of course, with the privilege of taking into account previous payments in fixing payments for future years. In Massachusetts, the insurance may either be in a mutual association of employers under state supervision or in any licensed mutual or stock insurance company. In Michigan the insurance may be in a state fund, in a licensed or stock insurance company, or by the employer himself satisfying the state board that by reason of his resources and the number of his employes, it will be safe to permit him to be the insurer.

In New Jersey, the law provides for the compensation of all accidents occurring while at work without regard to fault, and applies to all employers unless by written notice to a given state officer they elect to remain under the common law and the employers' liability act. If they do so elect, the "fellow servant" and "assumption of the risk" rules are abrogated, "the contributory negligence" rule can only be used to reduce the verdict, and the burden of proving "contributory negligence" is put upon the employer instead of, as previously, the burden resting upon the employe to prove that he was not contributorily negligent.

Under these different laws, elective in form, there have been very different results. Thus, as has been stated, exceedingly few employers accepted the provisions of the New York law.

In New Jersey, on the contrary, since it took an act upon the part of the employers to keep from going under the law, a very large proportion of them have accepted its provisions; but some large employers have refused to do so, among others the Standard Oil Company, while some other employers have obtained more advantageous rates by refusing to do so. There is no provision under the New Jersey law for mutual insurance. Consequently, a number of New Jersey employers have joined together to organize a stock company in which to insure themselves, hoping thereby to get lower rates.

In California, there is a good deal of complaint that the rates under the workmen's compensation act are materially higher than under the common law and employers' liability act, even with the defenses abrogated; and consequently many employers have not elected to come under the former. This complaint is also made in other states, notably Wisconsin, where, however, mutual companies are being organized under the encouragement of state authorities; and Ohio, where the stock insurance companies are making as strong a fight as possible to keep the business from going to the state insurance fund. The Michigan and Massachusetts acts have not yet taken effect.

In the state of Washington a compulsory insurance act took effect on October 1, 1911, requiring all employers to whom the act applies to insure with the state insurance fund. For the purpose of the fund they are divided into a good many classes, each of which must pay its own claims. In consequence, a few classes already show a deficit, but most of them show a surplus. The total premiums collected amount to about $500,000, the payments and reserves for sums payable hereafter on account of claims already arising amount to about 30 per cent, and expenses to about 15 per cent. The Washington law differs from the other laws in one other respect, *viz.*, that the amount payable in event of disability, *viz.*, from $20 to $35 per month during disability, and to the widow for herself and children, from $20 to $35 per month, varies not according to the wages, but according to the number of dependents.

In Montana, an act is in effect providing for certain rates of compensation to be paid to miners through the medium of compulsory insurance in a state fund, each employe, however, or the dependents of an employe killed by accident, having a right to elect, after the accident occurred, whether to accept this compensation or proceed under the common law or employers' liability law.

In the state of Nevada, notwithstanding the decision of the Court of Appeals of New York, an act was passed, requiring, subject to reduction of amount in event of "contributory negligence," all accidents occurring while at work which are not compensated under the common law or employers' liability law, to be compensated to the amount during disability of 60 per cent of the wages for a time until a maximum amount of $3000 is paid, and in event of death, a minimum of $2000 and a maximum of $3000.

Recommendations of Commissions

In addition to these plans, which have already gone into effect, bills have been introduced upon the recommendation of commissions, as follows:

In Congress a bill has been introduced to do away with liability at common law and under the employers' liability act, and to substitute a workmen's compensation act, calling for compensation for all accidents occurring while at work, without regard to fault. This will apply to railways only.

In Maryland a bill has been introduced by the commission which also seeks to repeal the common law, and employers' liability act, and to hold employers directly liable for compensation for all accidents occurring while at work, without regard to fault. This bill also makes provision for transferring the liability to mutual or stock insurance companies, and provides that if this is not done, all employers with less than $150,000 resources over and above all liabilities, or employing fewer than 1000 men, shall be required to insure in a state insurance fund. Provision is made for the compulsory insurance feature to apply to all employers in case the portion of the law, holding the employer directly liable, should be declared unconstitutional.

During the past year, the question of the constitutionality of some of these acts has been before the courts and decisions have been rendered as follows: In Massachusetts, the matter was submitted by the legislature before the act was passed, to the Supreme Judicial Court—which may be done in that state—and the proposed act was held to be constitutional. In Ohio the elective insurance act has been before the Supreme Court and has been held to be constitutional. In Washington, the compulsory state insurance act has been before the Supreme Court and has been held constitutional. In Wisconsin, the elective workmen's compensation act has been passed upon by the Supreme Court, and has also been held to be constitutional. In New Jersey, the lower court has passed upon the law and found it to be constitutional.

In Montana, the state insurance act, applying to coal miners, was upheld as constitutional in all respects but one, *viz.*, that it was discriminatory, and in violation of the rights of employers as depriving them of property without due process of law, in that, although an employer might have paid his premiums, his employes and their dependents might, at their own free will, sue him at common law and under the employers' liability act, and hold him responsible so that he would not receive any benefit from the insurance for which he had paid.

The benefits provided under these various acts vary as follows: Temporary disability, from 50 per cent of the weekly earnings, with a $4 per week minimum, and $10 per week maximum in Massachusetts, to 66 2/3 per cent of the weekly wages in Ohio, with a $5 minimum and $12 maximum. Six of the states fixed the percentage at 50 per cent, one at 60 per cent, two at 65 per cent and one at 66 2/3 per cent. The term of payment varies from 300 weeks in New Hampshire and New Jersey to the entire period of disability in Illinois (where the amount payable after eight years, however, is reduced), Ohio and Washington. The maximum amounts of total disability compensation when named in the laws, range in the neighborhood of $3000, except where compensation is payable throughout the disability, when no such limit applies.

In two states, New Jersey and Wisconsin, the employer, if under the workmen's compensation act, has no other liability. In other states his additional liability ranges from "intentional violation of a safety law" in Illinois, or "serious or willful misconduct of employer or his superintendent" in Massachusetts, to liability in all cases where the "employer is liable for damages under other liability laws" in Nevada. The employe is excluded from right to benefit on account of willful misconduct only in California, Illinois, Kansas (where it is limited to certain acts of misconduct), Massachusetts, Ohio and Wisconsin. In New Hampshire, intoxication also excludes, and in Nevada, wherever "contributory negligence" was solely responsible for the accident, that is, where it was wholly the fault of the employe injured.

In one state, Washington, where there is compulsory state

insurance, compensation is payable from the first day. In California, Illinois and Ohio the first week is excluded and in Wisconsin also unless disability lasts longer than four weeks, in which case the first week is also included. In Kansas, Massachusetts, New Hampshire and New Jersey, the first two weeks are excluded and in Nevada the first ten days, unless the disability last longer, in which case apparently the first ten days are also paid for. In all the states excepting New Hampshire, where to recover under the act calls for an action in equity (not requiring a jury) instead of an action at law, and New Jersey, where the court is directed to decide the matter "in a summary manner," an accident board is set up or a provision is made for arbitrators to make an award before the matter can be taken to the courts.

In the following states commissions have been appointed and are now at work upon bills to be introduced in the next legislatures, *viz.* Pennsylvania, Colorado, North Dakota, Missouri, Iowa, West Virginia, Nebraska, Connecticut, Rhode Island and Delaware. It is said that the Missouri commission has abandoned the task, no appropriation having been made. In Texas the governor was asked to appoint a commission to report to the legislature at its then session, but no appointment was made.

In Canada, all the provinces have now adopted workmen's compensation acts excepting New Brunswick and Ontario. In New Brunswick the employers' liability act was much extended in 1909 by modifying the defenses. The Canadian workmen's compensation acts hold the employer directly liable. In Ontario, the Chief Justice of the High Court has been appointed a sole commissioner to report a bill. The Canadian Association of Manufacturers and the representatives of workmen's associations have been before the commission and have joined in recommending a system of compulsory mutual insurance, through funds covering all sickness as well as accident during the early weeks, to which both employers and employes would contribute, and a fund covering death and disabilities beyond the first few weeks, due to occupation accidents only, to which employers will alone contribute. The Commissioner has just handed in a preliminary report, expressing favor for this plan.

European Laws Changed

In Switzerland, where for more than ten years past employers have been held directly liable for negligence, with the defenses abrogated, a compulsory insurance act has been passed, submitted to the people at a referendum and adopted by them. It provides for insurance against sickness as well as accident, covering the first few weeks, to which both employers and employes contribute, and for insurance covering death or disability beyond the first few weeks, due to occupation accident, to which employers only contribute. The state, however, makes contributions either directly or by meeting certain expenses in connection with each of these.

In Great Britain, no change has been made in the workmen's compensation act, which holds employers directly liable for the consequences of all accidents and some occupation diseases "arising out of and in the course of the employment;" but the principle of compulsory mutual insurance has been accepted with much favor, practically all the representatives in both houses of both the political parties voting for it, in the form of two laws, one requiring workmen to be insured against sickness and invalidity, and the other requiring them to be insured against unemployment. Toward these mutual insurances, the employers and employes both contribute, and the state also makes a contribution.

The main lines of the German system are as follows:

That accidents (during the early weeks of disability) should be compensated as well as all sickness, through sickness insurance societies to which employers and employes both contribute, and subject to their joint management.

That disabilities beyond the first thirteen weeks and all deaths due to accident while at work should be compensated through mutual associations of employers, to which employers only contribute and which are managed by them.

That as to both of these classes of associations, no more should be collected than is necessary to meet the requirements for the payments currently falling due, plus what is required for expenses, and a moderate amount in addition for the purpose of establishing a reserve, not intended to take care of future payments on account of claims already approved, but only to be called upon in event of a great and widespread disturbance of industry, so that many employes would be out of work and the payrolls of the employers low, in which case, if there were no such provision, obviously the rate of assessment might be very high.

The superiority of this system in economy of management, general efficiency, special efficiency in regard to prevention and the all-important respect of putting upon industry the smallest possible burden currently, was strongly supported both by representatives of employers and of employes, as well as by practically all who, from official or private viewpoint, have carefully investigated the matter.

It is proper here to say that none of the insurance plans so far introduced in the United States are of the same character. Thus the plan adopted in Washington, while dividing the employers into classes, leaves the management in the hands of a state commission. Moreover, the aim is to collect a sufficient amount to set up capitalized values for death claims and presumably, though not avowedly, also to hold sufficient reserves for payments thereafter to be made upon other claims. Certainly there is no indication that an "assessment" system, calling for no more money than is actually required for current payments, was in any sense intended.

The same is also true of the state insurance plan in Ohio. The law there does not require in definite terms the setting up of capitalized values, but from the nature of the system adopted, this is strongly implied. In Massachusetts, a distinct provision is made in the law for setting up capitalized value reserves and charging the state insurance fund with its unearned premium reserves, in the same general manner as would be applied to a private insurance company, whether mutual or stock. Under the state insurance laws of Montana and Maryland relating to coal miners, no special provision was made.

All of these appear to look for the plan to go into full effect from the outset, that is, the full burden falling upon industry from the beginning. Under the German plan, on the contrary, the idea was that the cost would be small at the outset, because only persons who were injured that year would be drawing money. It would be larger the second year, because then persons who were injured the first year and persons who were injured the second year would be drawing money, and in this way the cost would continue to increase for several years until an equilibrium was struck, which, if the risk remain precisely the same from year to year, would not be until from 25 to 50 years had passed.

This condition might be—and in many cases has been—very greatly modified by the introduction of excellent prevention, offsetting this natural increase by reducing the number of claims. A good illustration in steam railways, which started the first year at a cost of 0.39 per cent of the payroll, was 0.79 per cent the second year, 1.26 per cent the third year, and so on, reaching 1.80 per cent in the eighth year. This resulted in prevention so remarkable in character that there was an actual recession of the rate for several years, going down to as little as 1.26 per cent, notwithstanding that they were paying for persons who had been injured (and for the widows of those who had died) in every one of the twelve years previous. Since then, the rate has again increased, but for six or eight years past it has been about 1.80 per cent of the pay-roll—not higher than fifteen years before.

* * *

Calbraith P. Rodgers, the noted coast-to-coast aviator, was killed April 3 by a fall from his aeroplane, resulting from the attempt to perform a difficult spectacular evolution in the air over the beach at Los Angeles, Cal. Rodgers started for the Pacific Coast, September 17, 1911, from Sheepshead Bay, Long Island, and covered 3220 miles after many mishaps and accidents, but too late to win the $50,000 prize offered for the performance of the feat. Rodgers is the seventeenth victim of aviation this year, and the one-hundred and twenty-sixth since Lieut. Thomas E. Selfridge, the first, was killed near Washington, D. C., September 17, 1908.

DIES FOR RAISED LETTER NAME PLATES*

By CHESTER L. LUCAS†

Aside from the manufacture of the Sweetland chuck, for which the Hoggson & Pettis Mfg. Co., New Haven, Conn., is well-known, there is another line of work carried on in its factory that is of interest on account of the high degree of manual skill required to produce it. This work is the cutting of artistic steel stamps, a few impressions of which are shown in Fig. 1, and the making of dies for raised letter name plates, such as are shown in Fig. 3.

While it is the purpose of this article to treat especially of the methods used in the making of the name-plate dies, some of the stamp impressions shown are of considerable interest. It is difficult to illustrate such work to advantage. Of the impressions shown in Fig. 1, all of the script lettering is very difficult to cut in steel, for, of course, it must be cut "reverse," still maintaining its style. Monograms like some of those shown present difficulties of their own, for the various lines must cross and re-cross without breaks or deflections from their true directions. The "Old English" style of lettering is also difficult to produce in steel, and when the letters of a stamp are minute, as well as of difficult shape, like the small "Tannewitz" stamp near the center of Fig. 1, the troubles of the workman are not imaginary. The illustrations of the stamp impressions shown are considerably larger than the originals. Fig. 2 shows a workman engaged in making one of these stamps.

Fig. 1. Impressions of Artistic Stamps

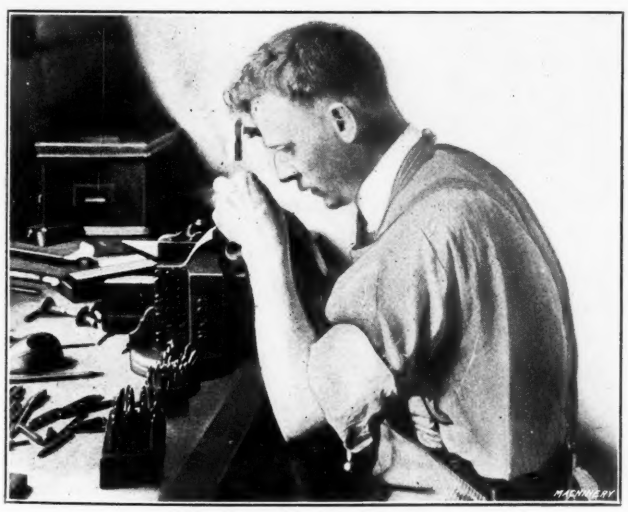


Fig. 2. Making Steel Stamps

The name plates or brass labels, as they are sometimes called, are usually made of very thin brass or aluminum, approximately 0.005 inch thick. They are used as name plates for light machinery, such as graphophones, sewing-machines etc., and for fire extinguishers, tanks, etc., to which they may be soldered. Still another use is in connection with the molding of rubber articles such as hot water bottles, when it is desirable to have lettering appear on the finished surfaces. As in other classes of die-work, the tools used for embossing these name plates comprise two parts, *viz.*: the die and the "force." In the majority of cases machine steel is employed for the dies, tool steel being used only for those dies which have a great deal of small detail or from which labels of thick material are to be made. If the die has been made from machine steel, the forcer, or force, as it is usually called, is made from soft white metal, but if the requirements of the work call for a hardened die, the force should be of brass or steel. Usually, however, machine steel dies and white metal forces is the combination employed. If the labels are to be used in mold-making, the reverse side of the plate must be

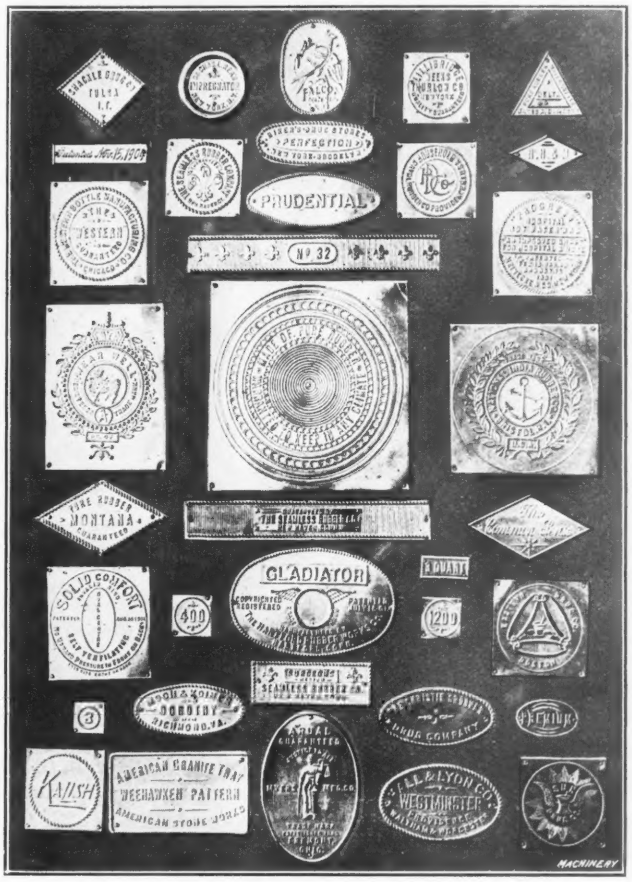


Fig. 3. Specimens of Raised Letter Name Plates and Labels

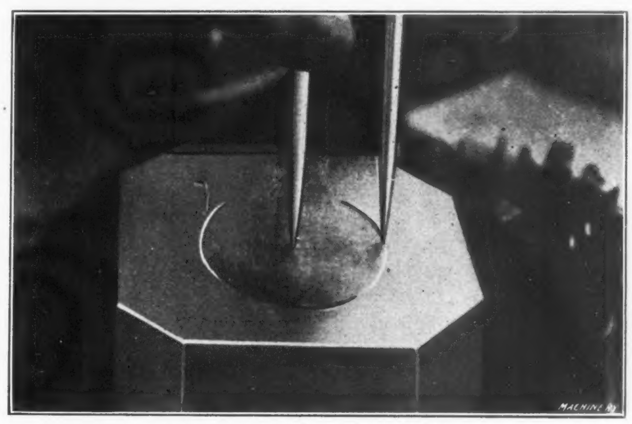


Fig. 4. Using the Cutting Dividers

* For articles on kindred subjects, see MACHINERY, April, 1912, "Brass Engraving by Machinery"; January, 1912, "Steel Letter Stamping Dies"; and June, 1909, "Coin and Medal Dies."
† Associate Editor of MACHINERY.

just as good as the front side, for the letters are formed on the rubber by means of its contact with the reverse side of the label.

Making the Die

The steel block from which the die is made is first faced off carefully and its surface coppered or blued, so that the laying-out lines may be easily seen. Let us assume that we are to make a die for the design shown in Fig. 5. The reason for selecting this particular design is that it involves a number of the different methods of die-sinking that are not often employed on one design.

After the main lines of the design have been laid out on the die, faint circles are scribed with cutting dividers to guide the die-sinker in stamping the fancy border near the outer edge and the bead border between the lettering and the design. This operation is shown in Fig. 4. The cutting dividers are merely an old pair of dividers, one leg of which has been ground with a cutting lip. This tool is very convenient for cutting grooves. The plain line borders and other circles are not cut at this time.

In stamping a bead border like the inner border shown, a double punch is made use of. One of these double punches is illustrated in Fig. 6. The object in making the punch with two stamping units is to provide a means for properly spacing the impressions. After the first two impressions, but one impression is stamped at each blow, half of the punch being used as a spacer, after the manner of a spacing center-punch. As soon as the entire border of beads has been stamped in, a single beading tool is used to go over the impressions, leaving each bead perfectly shaped. After each of these two stamping operations, the burr raised by stamping is faced off with a file.

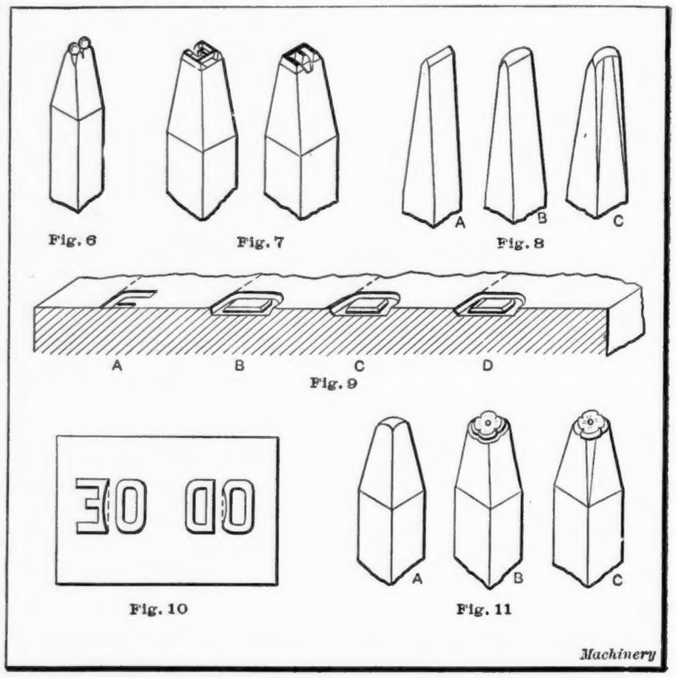


Fig. 5. The Face of a Name-plate Die. Fig. 6. A Double-bead Punch. Fig. 7. Comparison between a Die Letter and an Ordinary Stamping Letter. Fig. 8. Three Types of Lining Tools. Fig. 9. Illustrating Points in Stamping. Fig. 10. How Close Stamping displaces the Steel. Fig. 11. Three Steps in Making a Punch

Often the design is surrounded with a plain line-border. If the design is circular, such a border may be cut with the cutting dividers, but if rectangular or of other than circular shape it must be punched in with a lining tool or a straight-line punch in the manner shown in Fig. 12, the punch being moved ahead half its length after each imprint. Should it be necessary to have a wide flat border, it is best to chip out most of the metal, and then smooth up the lines by means of a punch of the right width.

Fig. 12. Stamping the Lines of a Design

Fig. 13. Making a Punch from a Master Block

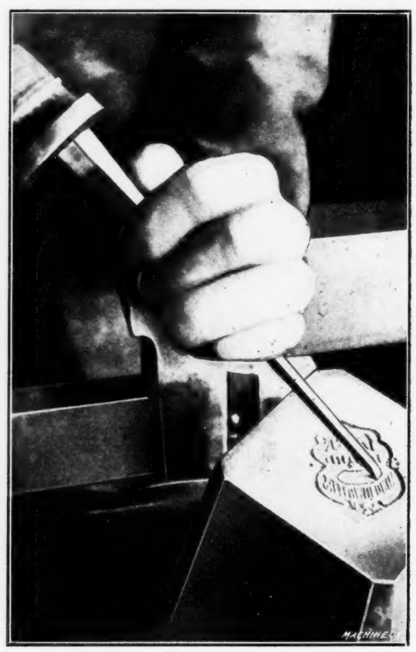


Fig. 14. Chipping out a Panel in a Name-plate Die

Next in order comes the outside border which in this instance is made by stamping with the single border tool around the border-line, using the faintly cut line as a guide. A good many die-sinkers use only a scribed line to which to stamp a border, but some border tools are very difficult to use, unless a deeper guiding line is provided. It is essential

that the border shall "come out even," that is, that it shall be spaced uniformly at every part of the circle. It is customary to employ double punches only for bead or rope borders, because the units of other borders are so much larger that trouble would arise in spacing the last few units. Nine out of every ten borders of name plates are, however, either plain, beaded, or of rope pattern.

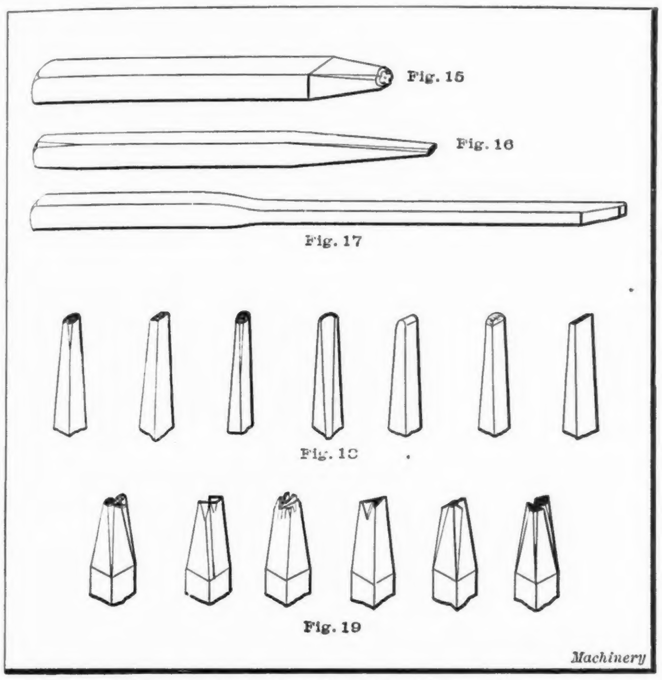


Fig. 15. Proportions of a Punch 3 1/2 inches Long. Fig. 16. Proportions of a Chasing Tool 4 inches Long. Fig. 17. Proportions of a Chisel 6 inches Long. Fig. 18. Various Styles of Chasing Tools. Fig. 19. Various Border Tools

Before stamping the last few units of a fancy border, the die-sinker usually measures the remaining space with his dividers and compares it with a section already stamped, to see if it will be necessary to space the remaining units differently in order to make them "come out even." Sometimes the last few units must be spaced either closer or farther apart to avoid having half a unit left over. This half-unit of blank space would be very noticeable if not distributed over several units. Referring to the design, Fig. 5, it will be noticed that the border has been spaced very evenly except between the points directly over the "L" in "Eagle," and the "H" in "Machine." Within this short distance the six units have been slightly spread to make up for the half unit that would otherwise have been left over. This slight discrepancy in spacing is not noticed by those not familiar with die-making. Samples of border tools are shown in Fig. 19.

Stamping in the Letters

The borders being successfully stamped in, attention is directed to the lettering. From the center point of the design, if circular, limiting circles for the letters are scribed. While great care is taken to make the limiting circles for the letters of correct dimensions, the letters themselves are only roughly spaced. If the lettering is different from any that the die-sinker has previously stamped, it is well to first stamp the letters lightly upon cardboard, although a very common way is to merely count the letters and spaces, and start the stamping with the central letter upon the central dividing line of the design, which in Fig. 5 runs through the "I" in "Machine."

In stamping in these letters, the eye is almost entirely depended upon for getting their positions right. The faces of the letters on the stamps are made different from ordinary stamping letters, in that they are not reversed and also that they are not sharp-faced, but have narrow flat faces. A comparison between steel stamping letters and die letters is shown in Fig. 7. In stamping, the stamp is held with the bottom half of the letter even with the line, being tipped slightly toward the stamper. After striking the stamp lightly in this position and having found it to be in the proper location relative to the line as illustrated at *A*, Fig. 9, it is refitted into the lightly stamped impression, tipped up straight and the other half of the letter struck in, the result appearing as at *B*, Fig. 9. If, however, the first impression is not in line or is crooked, it may be corrected by the stamp being moved slightly in the proper direction. Two of these corrected impressions appear at *C* and *D*, Fig. 9. The lighter that the preliminary stamping is done, the better. After all of the letters have been lightly stamped, they should all be driven in to a uniform depth of 1/64th inch, taking care to have all parts of the lettering of even depth.

All stamping of any kind displaces the stock immediately surrounding the letter stamped. Some of the metal rises above the surface of the die in the form of a burr, and some is crowded away at the sides, often distorting a letter that has been previously stamped. Especially is this true when the lettering is closely spaced. To overcome this trouble, it is best, after stamping a letter, to go back to the preceding letter and re-stamp it lightly. This will throw the displaced steel upward in a burr. If, however, the letters are very closely spaced, this re-stamping will simply push the metal back into the new impression, and to avoid this, the displaced steel should be cut away, as indicated by the dotted lines in Fig. 10, after which a tap with the stamp will finish the work.

As already mentioned, those lines which are not circular arcs must be stamped or traced with a straight-line punch or a lining tool. Lining tools are of three distinct varieties, shown in Fig. 8. *A* is for straight lines; *B*, for slightly curved lines; and *C*, for very sharp curves. If the faces of these lines must

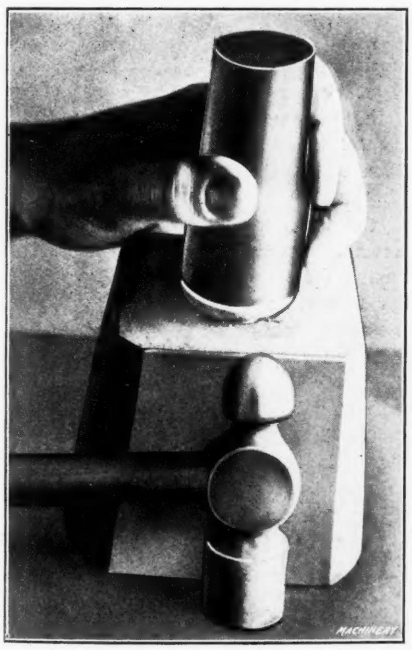


Fig. 20. Taking a Wax Impression to get the Effect of the Finished Work

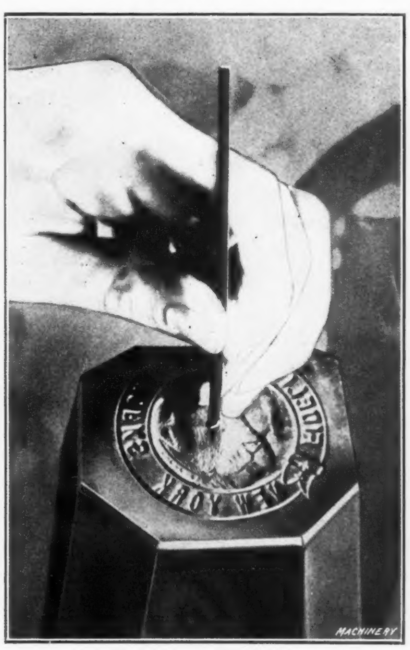


Fig. 21. Working on the Design—Using a Chasing Tool

Fig. 22. Working on the Design—Using an Engraving Tool

be flat or curved, special lining tools may be made to suit the work. The panels in the central part of the design shown in Fig. 5, may be outlined and the two dashes at the ends of "New York" may also be stamped. Other parts like the arrows and the leaves may also be easily stamped by making one or two special punches, thus saving considerable time that would otherwise be spent in hand-engraving this part of the work.

Making Special Stamping Tools

Special stamping tools should be made of Jessop's steel, if possible, using square bar stock for all standard punches except those that are very large. Generally speaking, these stamping tools, exclusive of those for the die letters, may be divided into two classes: punches and chasing tools. The general proportions of these tools are shown in Figs. 15 and 16, and although every die-sinker has his own ideas, those shown will be found to be of about the average type. Moreover, while every die-sinker would like to have his tools of standard lengths, they are constantly subject to breakage, and if redressed are consequently shorter, until, if care is not taken, chasing tools and punches will be of "all lengths." The chisel in Fig. 17 is six inches long.

Chasing tools, a box of which is shown in Fig. 12, should be made about four inches long. They should be of various shapes, a few of which are shown in Fig. 18, and there should be several sizes of each shape. The sides are filed with very little bevel as they are made to do very little work, their chief use being in smoothing up the design in the die. These tools should be hardened and drawn to a dark straw color.

Punches should be made about three and one-half inches long and of much heavier steel than chasing tools, as they have to be driven into the die. While many designs must be originated, a good deal of time can be saved by using a master block like that shown in Fig. 13, to aid in making special tools. This block is hardened. A blank punch is filed so as to have its face

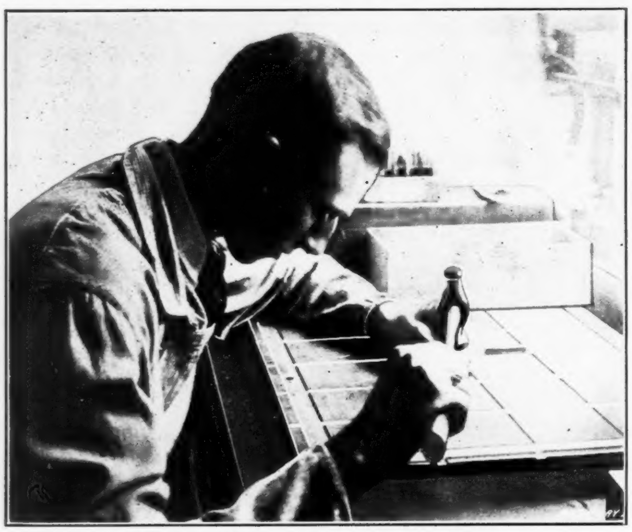


Fig. 23. Lettering a Mold for Rubber Heels

slightly convex as shown at A in Fig. 11; it is then driven into the proper impression which will form the design on the end, leaving it in the condition shown at B; and lastly, the steel around the design is filed away to the proper bevel and the punch, as shown at C, is ready to be hardened. After hardening, the temper should be drawn to a medium straw color, unless the design is deep, when it may be drawn still more.

Fig. 20 shows a die-sinker taking a wax impression of his work, in order to see how it is going to look on the finished name plate. The best and cheapest way to obtain this wax is to purchase a pound cake for thirty cents; a pound will last for years. Receipts for making this impression wax are given in MACHINERY's "Shop Receipts and Formulas." The wax is used on the end of a short block of wood. The die-sinker cleans out the die, breathes on its face to form a film of moisture, and then drives the wax into the impression. Upon gently removing the block, the wax is removed and every detail of the work may be plainly seen. While stamping in the lettering, impressions are frequently taken to indicate those letters which are uneven in depth or crooked, so that they may be corrected.

After the stamping of the letters, borders and other parts has been finished, the next step is to cut any rings or grooves like those shown in the design in Fig. 5. If there are a large number of these rings, or if they are deep, it is best to set up the block in the lathe and turn them, but for dies that have only two or three such rings, they can be cut more easily with the cutting dividers. The reason for leaving the cutting of these rings until after the stamping has been finished, is to avoid distorting them by displacing the metal during the stamping.

Engraving the Design

The most difficult part of the making of a die of this character consists in engraving those parts that cannot be stamped. In the design shown in Fig. 5, this part is, of course, the eagle. The first step consists in facing off the surface of the steel very smoothly, after which the design is very carefully drawn. The outlines are then cut lightly with an engraving tool, and if the design is deep, chisels are employed for cutting out the bulk of the steel, as shown in Fig. 14. The general proportions of these chisels are shown in Fig. 17, and the shapes

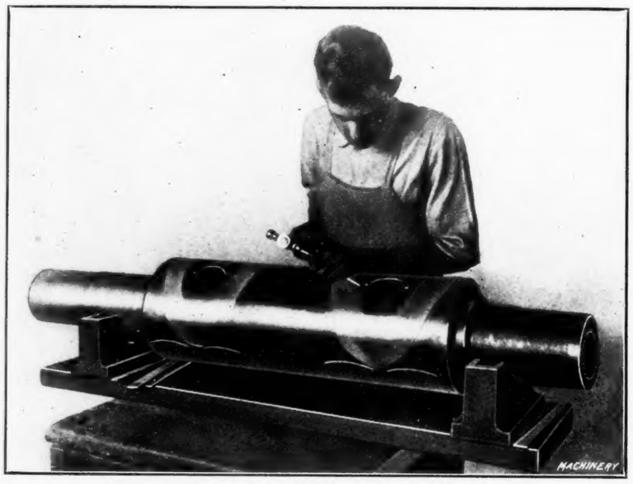


Fig. 24. Cutting the Pattern on a Calender Roll

most often used are the flat and half-round. The final finishing of the details is accomplished by means of chasing tools used as shown in Fig. 21, and by engraving tools as shown in Fig. 22.

Engraving tools of various shapes and sizes are employed for the different angles and curves of the design. The ring used in Fig. 22 protects the design from the under side of the tool, and is especially useful in sinking deep dies. Frequent wax impressions are taken to aid the die-sinker in perfecting the details of the design.

The very last step in the work consists in "matting" such places as the panels shown in the design in Fig. 5. Matting tools are varieties of chasing tools used in pebbling or matting parts of the die in order to form a contrast with the smooth parts. After matting, no filing can be done on the surface of the die, as this would injure the delicate finish left by the matting tools.

Specimen labels may be struck from the die before the top die, or force, has been made, by placing the die under a small drop press, or a screw press, laying the blank name plate upon the die, and placing either a piece of sheet lead, 1/8 inch thick, or a piece of leather belting, over it. By striking several blows upon this soft backing a good specimen of the work that will be produced by the die will be obtained.

Should the die require hardening, it should be done in the manner described in the article "Coin and Medal Dies" that appeared in MACHINERY for June, 1909.

Making the White Metal Force

While the most difficult part of the die is the engraving of the lower block, it is just as essential that the force which is used be fitted properly and that it fill the design in every detail, so that it will be possible to strike up labels or name plates that will be perfect on the reverse side as well as on the face side. This is important on dies of this character, because the metal from which the labels are made is very thin and will not be forced into the design unless it is backed up in every detail by the force.

White-metal forces are made by first fitting the face of the die with a temporary wall, usually made of pasteboard. Into this enclosure molten white metal is poured until it has reached the depth of approximately ⅜ inch. The white-metal force is then struck into the die under a drop or screw press, after which it is ready for use.

The labels themselves are struck up by holding the die in the screw press, the die block being held by screws in a bed-plate, and the white-metal force being held to a flat block in the ram of the press by means of the contact secured by a thin film of beeswax. The thin brass is cut into squares large enough to make the labels, and each of these squares is in turn laid upon the die and the ram of the press brought lightly down so as to force the brass into the design of the die.

If the work is of such a nature that the die must be hardened, the force should be of copper or steel, and as the making of such forces involves many different processes, this phase of the matter will be described in a later number of MACHINERY.

Figs. 23 and 24 illustrate phases of die-sinking operations in connection with rubber mold work. In Fig. 23 the workman is lettering a mold for rubber heels, the work being done in the same manner as the die work just described. Fig. 24 shows the way in which the outlines of rubber shoe patterns are cut on a calender roll with chisels. Afterwards the lines are smoothed with punches, and the surface of the roll filed smooth. Thus, when the plastic rubber is rolled under one of these calender rolls, the rubber sheet emerges from the other side of the roll with the patterns outlined on it, ready to be cut out and put together.

* * *

SPECIAL MEETING OF THE A. S. M. E.

A special meeting of the American Society of Mechanical Engineers was held in the auditorium of the Engineering Societies Bldg., New York, April 9 in honor of the commission of the German Museum of Masterpieces of Natural Sciences and Technical Arts, visiting America. An illustrated lecture prepared by Dr. Oscar Von Miller on the work of the commission, was read by Mr. Charles Whiting Baker. The lecture described the German Museum at Munich, Bavaria, its aims and methods. The method of the German Museum is to correlate and arrange machinery, apparatus, architecture, processes, industries, etc., in order of development and thus produce progressive historical presentations of the arts and sciences to date. This admirable conception has been carried out with characteristic German thoroughness, and the views illustrating the lecture, showed the arrangement of interesting mechanical groups, chemical apparatus, astronomical instruments, etc. Of special interest was the reference to means by which visitors can demonstrate the working of a machine or a chemical reaction by simply pressing a lever or knob.

The importance of preserving in convenient locations the progressive developments of the arts, can hardly be overestimated. The history of inventions thus shown in concrete form should serve in many cases to prevent inventors and manufacturers from making serious mistakes by developing old ideas over again and thus wasting time and effort needlessly. Museums developed on these lines become educational institutions of high order instead of show places for jumbled and unrelated things.

* * *

According to *Eastern Engineering*, screws are still made in India just as they were made hundreds of years ago, that is by winding two soft wires side by side around a mandrel. The wires are then carefully separated and one of them is soldered to the inside of a tube, which then will form the nut, while the other is soldered to a mandrel or rod. All the screws are left-handed, because they are wound over and over by the right hand.

* * *

Owing to the limited knowledge of many draftsmen as to the qualities of materials used in machine construction, there seems to be a tendency to specify better materials on drawings than are actually necessary for the part. Thus, frequently, tool steel is called for where machine steel, case-hardened, would serve the purpose equally as well—and sometimes better.

DIFFERENTIAL MECHANISM ON GEAR HOBBING MACHINES*

By WILLIAM NATISCH†

The writer has read many articles relative to gear cutting machines of different constructions, but has not seen any comparison made between a hobbing machine with differential mechanism and one without it. A great number of mechanics do not know how important it is to have a differential mechanism—or simply a "differential"—on gear hobbing machines. If we take time-saving and accuracy into consideration, a differential mechanism which combines the indexing and helical feeding movements of the table is absolutely necessary. We would not need this extra adjustment for the helical movement if there were no prime numbers between one and ten million.

When generating helical gears on hobbing machines without differential, the required ratio which combines index and feed gears must be calculated at least with 7 decimals, as otherwise a large error will result which will impair the accuracy of the gears. It frequently happens that the required ratio consists of prime numbers, especially when cutting right- and left-hand gears with one hob. To produce correct helical gears with their axes standing parallel to each other, the errors for the right- and left-hand spirals must be absolutely the same, otherwise there will not be a bearing on the whole length of the teeth. In fact, exactly the same conditions exist with helical gears as with spur gears. If, for instance, the teeth of one of two spur gears stood at an angle of only 5 seconds with its axis, the bearing would be at one end of the teeth only.

Furthermore, if the hobbing machine has a differential, it is not necessary to have a right- and left-hand hob when cutting any angle up to 30 degrees; on the contrary, a higher efficiency is obtained when using only one hob for both right- and left-hand spirals. The reason for this is very simple: if there is any distortion in hardening, the right-hand hob will be different from the left-hand.

It has been mentioned before that the ratio must be calculated to at least 7 decimals when cutting the gears on machines without differential. The belief of many mechanics that the ratios and errors obtained by formulas are alike for all hobbing machines, with or without differential mechanism, is entirely erroneous. There is a great difference between the two ratios. In the one case the ratio represents the value of the indexing and the helical movement, and the slightest change of the "driver," *viz.* numerator, will cause a great error if the "driven," *viz.* denominator, is not also changed in the same proportion. In the other case, *i. e.* with the differential, the ratio obtained refers to the angle or helical movement only, and adds or subtracts itself automatically to or from the ratio of the indexing gears. The indexing gears required for cutting helical gears are given on a chart and can be read off the same as for spur gears. This is impossible without the differential. The difference between the two ratios is explained in the following example.

Example:—Gear, 48 teeth; 10 pitch; 20 degrees; 1/16 inch feed per revolution of table.

Gear ratio of machine with differential for 20 degrees = 1.2052784.

If we deduct 1 from the third decimal which is 5, and omit the rest, we have 1.204 = ratio for 19 degrees 58 minutes 42 seconds; *i. e.*, 1 minute 18 seconds difference.

This shows how slight the error would be if we were to change the third decimal; in practice the change is made on the fifth decimal, and the error almost eliminated.

For the same pitch, number of teeth, angle and feed, the gear ratio for one of the machines without differential equals 1.2517385. If here we were to deduct 1 from the third decimal and omit the rest, the result would be that instead of generating teeth the material would simply be milled off from the blank. This is explained as follows: Gear ratio for 20 degrees is 1.2517385. When deducting 1 from the third decimal we obtain 1.250, which is the spur gear ratio.

* See MACHINERY, December, 1911, engineering edition: "Calculating Gears for Generating Spirals on Hobbing Machines."

† Address: Care of Schuchardt & Schütte, 90 West St., New York.

The Schuchardt & Schütte gear hobbing machines are provided with a differential which on the new type of machines is independent of the feed and indexing; in other words, when changing the number of teeth, or feed, or from right- to left-hand gear, no calculation is required. Thus the great advantage of the differential mechanism is that the helical movement is not disturbed whatever when the number of teeth is increased or decreased or the feed is changed. Suppose we intend to generate helical gears with 30, 40, 56 and 60 teeth, of which those having 40 and 60 teeth are left-hand, and those having 30 and 56 teeth are right-hand; the spiral angle is 15 degrees; the pitch is 10. The material is supposed to be cast iron; therefore, 1/16 inch feed per revolution of the table would be selected as the proper one. All the gears are to be cut with one right-hand 10-pitch hob. In calculating the change gears used when generating these gears on the Schuchardt & Schütte machine but a few minutes will be required, the following formula being used:

$$\frac{\text{Constant} \times \text{sine of angle} \times \text{pitch}}{1} = \text{ratio.}$$

$$\frac{0.3524 \times 0.25882 \times 10}{1} = \frac{912}{1000} = \frac{19 \times 48}{20 \times 50} = \frac{\text{driving gears}}{\text{driven gears}}$$

On machines not provided with a differential mechanism, every gear of the same pitch, with only a different number of teeth, must be calculated for separately, and the slightest change in the feed will require a separate calculation. A change in the formula must also be made, if right- and left-hand gears with the same number of teeth are cut with one hob.

The differential is also of great importance when cutting worm-gears with a taper hob. Worm-gears for worms with multiple threads ought to be generated with taper hobs if high efficiency is required. The writer believes that hobbing machines without differentials will disappear after the patent expires.

* * *

HANDLING A LARGE JOB OF MILLING ON A SMALL MILLING MACHINE

By CHESTER L. LUCAS*

The casting shown upon the table of the Van Norman duplex milling machine that appears in the accompanying illustration is the main casting for a wood screw threading machine, designed and built by H. P. Townsend, Hartford, Conn. The casting was first milled on the under side to provide seats

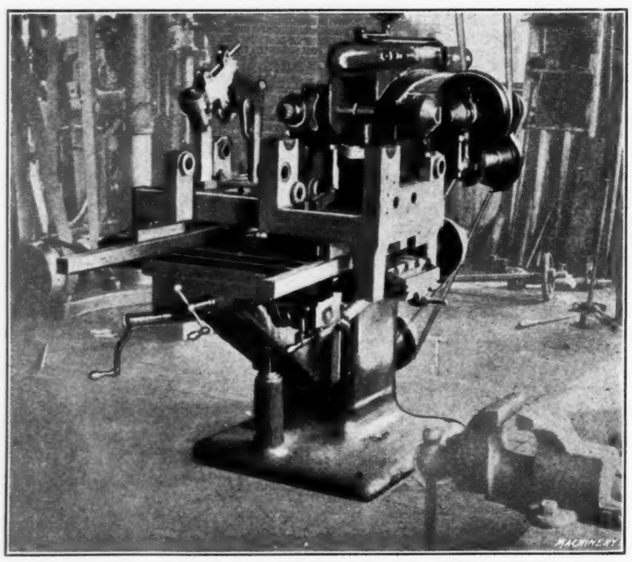


Fig. 1. The Work Set up for Milling the Tops of the Bearing Posts

to receive the parallels. The piece was then set up as shown, and by means of the vertical attachment the tops of the boxes and several bosses and raised panels that were located between the bearing posts on the bed of the casting were faced off. Next the casting was clamped on the table of the machine in a position at right angles to the one shown and the end of the casting faced off, after which the casting was reversed and the opposite end machined. In this latter position the holes that may be seen through the end of the casting and the bearing posts were bored and counterbored by means of suitable boring-bars. When setting up for boring the holes which were farthest away from the head of the machine, it was found that the overhanging arm was not long enough to support the end of the boring-bar; consequently an improvised bracket was brought into use and clamped to the end of the casting. By means of a bearing hole, which was in line with the holes to be bored in the main casting, the end of the

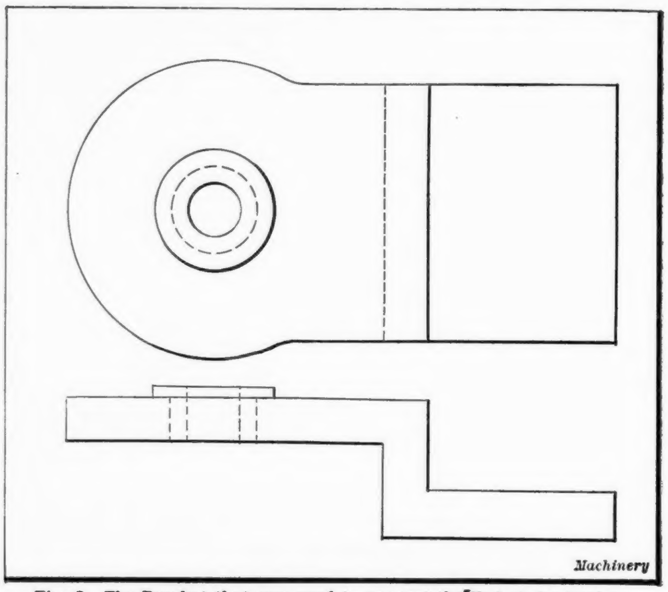


Fig. 2. The Bracket that was used to support the End of the Boring-bar when boring the Holes in the Bearing Posts

boring-bar was adequately supported and the job successfully finished.

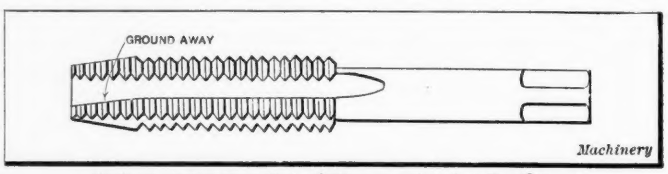
The fact that the table of this machine is wider and longer than that of other machines of its type, and that the table travel in both directions is also greater, together with the fact that the machine can be converted into a vertical milling machine in a few seconds, explains how this job was possible on so small a machine.

* Associate Editor of MACHINERY.

* * *

TAPPING HARD METAL

A useful kink for tapping hard metal is given in the *Practical Engineer* (London). When hard metal has to be tapped it is very common that the taps break; if the tap is ground, however, as indicated in the engraving, no difficulty will be experienced. The effect of the grinding removes the front



Method of Grinding End of Flute for Tapping Hard Metal

part of the teeth, so that the cutting edge presented forms a different angle with the thread than on the section not ground away. This method of grinding the tap proved successful in tapping very hard rolled steel plates.

* * *

CATERPILLAR ATTRACTION

Mr. Hickman, the self-made man and "super" of the United Street Railways, was enthusiastically explaining the construction and merits of his new journal-box to a friend who had dropped into the super's office:

"But I don't see how the oil gets up to the journal," objected the caller.

"Oh, that's easy; it's done by caterpillar attraction. You see the oil climbs up these wicks just like a lot of caterpillars going up a tree. Simple ain't it?"

* * *

A very disagreeable feature about some foremen is that if a piece of work goes well, it is "I," but if anything goes wrong, it is "You."—*Exchange.*

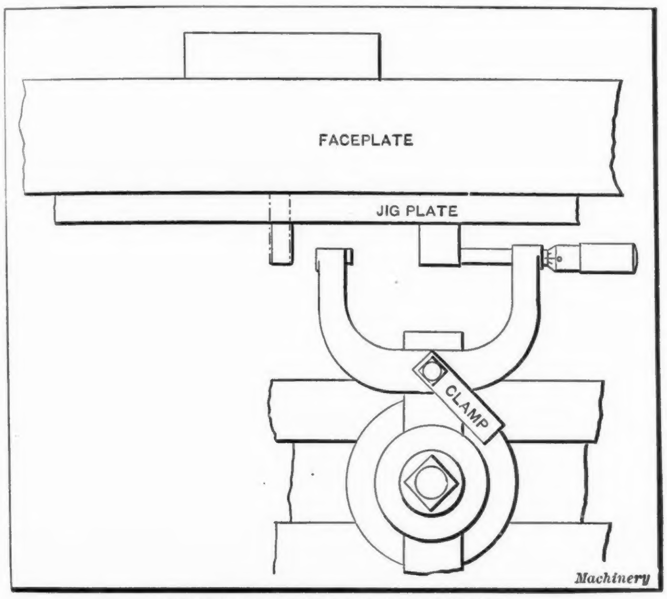
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

LOCATING HOLES TO BE BORED ON THE MILLING MACHINE—A COMMENT

In the April number of MACHINERY an article entitled "A New System for Locating Holes to be Bored on the Milling Machines" is published. The writer wishes to make some comments on the method there explained.

In doing any work, the fewer the liabilities of error the more accurate will be the results. The method referred to does not seem to fully take account of this indisputable axiom. In the layout, one begins with an edge on one side of the plate and then proceeds from a second edge which must be exactly at right-angles to it. If these two edges are at right angles, then the two lines *AA* and *BB* (shown in Fig. 1 in the April number) will be at right angles, but here is a possibility for an error at the very start.



Method of Adjusting Location of Center

The problem presented, as the writer understands it, is to locate with extreme accuracy the two centers *C* and *D* a given distance apart. There are two ways of locating a point; that is, by vision or by feeling, and in the method referred to the latter is adopted. Lines are scratched at right angles to each other; the three feet of the center locating punch are, by the sense of feeling, made to engage with these scratched lines, the center thereby being located at the intersection of the lines. Here, again, are chances for errors. The center plunger may not fit closely, its center may not be ground exactly concentric with the body of the punch, or the feet may not be exactly in their right positions. Furthermore, the punch may not be placed exactly as required. It is admitted, however, that the form of point used for scratching the lines seems to be very good, and the two lines scratched by it would show a very clear point of intersection.

The writer also fails to see the value of the indicator illustrated and questions the advantage of a hole and plug over the visual system. Of course, the taper hole in the milling machine spindle may be perfect, but it is not likely to be, except when the machine is new. In using the indicator, the writer would revolve the milling machine spindle, and not the sector as explained, in order to be more likely to have the center of revolution of the spindle established in so doing.

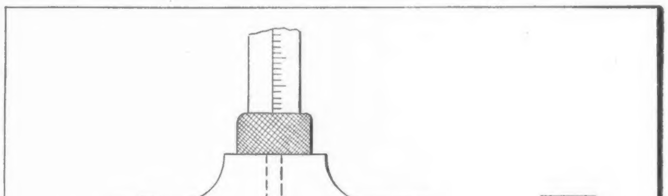
If the piece of work were, say, 10 inches long and square, the writer would locate and bore the hole in the lathe. The faceplate would first be trued off; that should be done at a time when the job could be finished before night, as for very accurate work the escape of oil in the bearings of the lathe over night will affect the accuracy. Should it be required to have the point *D* located a given distance from side *F*, line *AA* could be laid out by means of a try-square, the accuracy of which is easily determined, allowing about 0.005 inch for grinding after the two holes were bored. Line *BB* could be drawn with a height gage.

After locating point *D* by means of a common center indicator, a parallel should be bolted to the faceplate so as to allow the sliding of the plate along it after the first hole is bored. Assume that the two holes are 2 inches apart and each is to be ½ inch in diameter; before boring the first hole set a pair of dividers to 2 inches, and from center *D* scratch a line across *BB*, so as to approximately locate point *C;* then bore the first hole to gage and fit it with a plug, the plug projecting say ½ inch. Now loosen up the holding clamps or bolts and slide the plate along the parallel and with the indicator locate the second hole *C* and bore it to ¼ inch diameter; then fit a plug into this hole and measure with a micrometer the distance over the outside of the two plugs. If the reading should be 2.375 this would indicate that the setting is exact, but this would seldom happen, and the error found may be 0.005 inch over this dimension, which means that center *C* is located 0.005 inch too far away from *D*. The error being known, it can now be corrected without further trial, and to do this the micrometer is clamped to a tool held in the toolpost, as shown in the accompanying illustration. The reading of the micrometer is brought to zero and the point of the micrometer screw is brought into contact with the ½ inch plug. Then loosen up the clamps and feed the plate 0.005 inch by means of the screw, reclamp the plate, and bore the second hole to a ½ inch diameter. The centers now will be located exactly 2 inches apart. If there be any errors they will be found rather in the production of the holes than in the locating of the centers.

It may be merely a personal peculiarity, but the writer always trusts the "feel" of a pair of calipers rather than a stiff gage or a micrometer; but the great advantage of the latter lies in that it tells exactly how great the error is instead of merely denoting that there is an error. NEW LONDON

TOOL FOR MEASURING THE WIDTH OF THE POINT OF U. S. THREAD TOOLS

The accompanying illustration shows a tool for measuring the width of the flat at the point of U. S. thread tools. The device consists of a block of steel, say, 1 inch by ½ inch, with a 60-degree V-groove, and a hole for the rod of a depth gage. There are also two flat springs to hold the depth gage to the block. In making the block, a ¼-inch plug gage is laid in the vee, and the top surface *A* of the block on which the depth gage base rests, is ground until the gage, when in contact with the plug, reads 0.625 inch. To measure the width of the flat of a tool point, set the gage at zero, slip it under the springs, and run the rod out ½ inch. Now insert the tool to be measured in the vee and measure to its point with the depth gage. The amount that the gage reads over ½ inch, multiplied by 1.1547, equals the width of the flat of the thread tool. If it is required to set the tool for any desired width,



Tool for Measuring the Width of Flat on Thread Tools

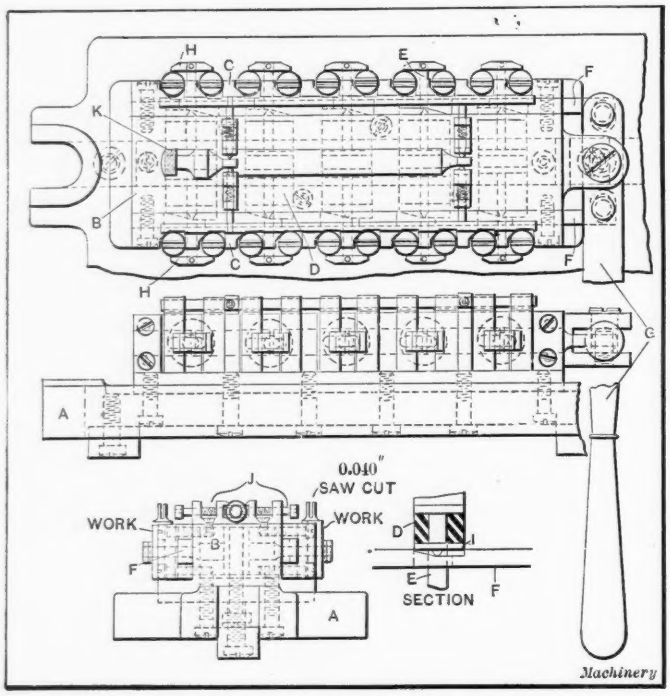
multiply this by 0.866 and set the tool to ½ inch plus this product.

Revere, Mass. GUY H. GARDNER

[The accuracy of the rules given above for setting this tool can easily be ascertained by anyone who knows the first principles of the solution of triangles. A tool similar to the one described, but somewhat more elaborate in its design, and intended exclusively as a thread gage for the width of flat on thread tools, was illustrated and described in MACHINERY, April, 1907.—EDITOR.]

A MULTIPLE MILLING FIXTURE

The milling fixture shown in the accompanying illustration was designed for holding the small pieces illustrated, which were made from a cast composition. As the parts produced were not of exactly the same size, it was necessary to provide some means so that the clamping members would hold all the parts rigidly. We had some rubber in our works which, upon testing, was found to have considerable resiliency; this gave me the idea that we could overcome the difficulties presented in clamping by using rubber collars as an equalizing medium to provide for the variations in the diameters of the work.



A Multiple Milling Fixture for Holding Pieces of Varying Diameters

The fixture shown in the accompanying illustration consists of a base casting *A* to which a central block *B* is held by screws. The two jaw strips *C* which are milled out, as shown, to fit the work are, in turn, fastened to the block *B*. This center block *B* is bored out to receive the rubber collars *D* and draw-in spindles *E*. The two sliding bars *F*, of rectangular section, are milled to fit a slot in the jaws *C*, and are operated by the handle *G*. The clamps *H* are pinned to the draw-in spindles *E* provided with a head against which the rubber collar *D* is compressed by the pressure plates *I*. These pressure plates are provided with projections which operate in the beveled slot in the sliding bars *F*.

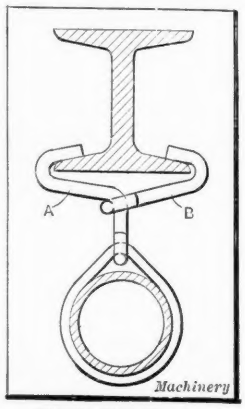
As the handle *G* is fulcrumed in the block *B* and is pivotally connected to the sliding bars *F*, it will be seen that by moving the handle *G* to the right, the sliding bars *F* are moved in opposite directions to each other. The resulting action of the tapered portion of these slides forces in the pressure plates *I*, compressing the rubber collars *D* against the collars on the draw-in spindles, and thus operating the clamps. It is, therefore, evident that by interposing these rubber washers, compensation is made for any variation in the diameters of the work.

The mechanism shown at *J* consists of two strips which extend along the entire length of the jaws, and is used for lining up the pieces parallel to the fixture after they have been placed at random in the jaws. To operate this device, the rod *K* is pushed in which forces the longitudinal strips against the work bringing them all in line, so that they can be clamped, and the cut taken. This fixture makes a very compact device and can be adapted to a large range of small work, which is difficult to hold in an ordinary fixture.

V. W.

SIMPLE PIPE HANGER

About two years ago the writer was requested to design some pipe hangers for a 4-inch steam pipe supported from an I-beam in the factory. The hanger as shown in the accompanying engraving is very simple, as it is made entirely from ⅜-inch iron rod. The clamp grips the beam more strongly, the greater the weight that is applied to the hanger. Being made without bolts, it is simpler to put in place than many of the pipe hangers one sees regularly about the shops, and there are no holes to drill. Part *B* should be made short enough so that it will act as a fulcrum for hook *A*, as otherwise the hooks will not grip the I-beam properly. This is really the most important point to be considered in the making of this simple hanger.

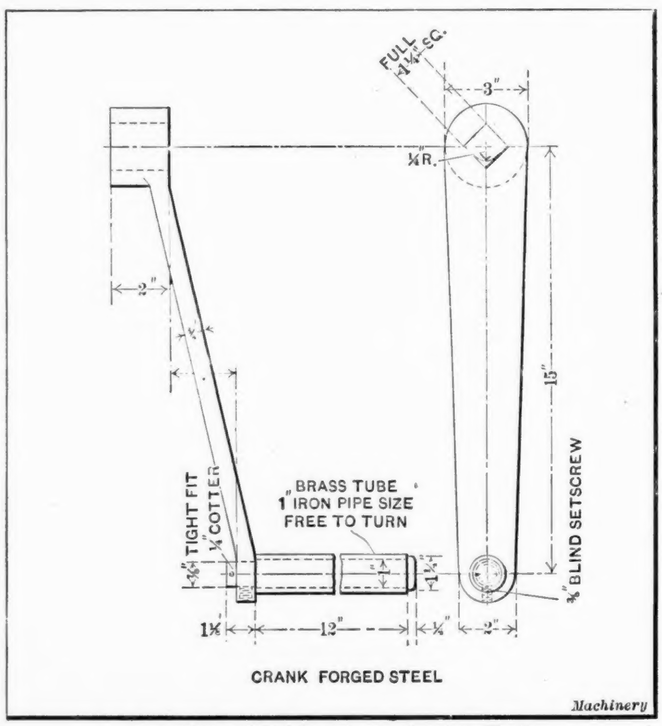


Simple Pipe Hanger

S. Boston, Mass. JOHN WALSH

PROPORTIONS OF HAND-CRANKS

The proportions of hand-cranks given in the December number of MACHINERY, interested me very much. While not attempting to criticize the proportions and design there given, I would like to submit a more suitable crank for out-door work. Hand-cranks are used in all climates and under various conditions, and are subject to much abuse. A handle twelve inches long is about right for a one-man affair, but who can tell whether one or two men will operate the crank? Twenty-five pounds is a good "all day" allowance as a working load



Proportions of Hand-cranks for Out-door Work

for one man, but it is an easy matter for him to exert seventy pounds for a short time.

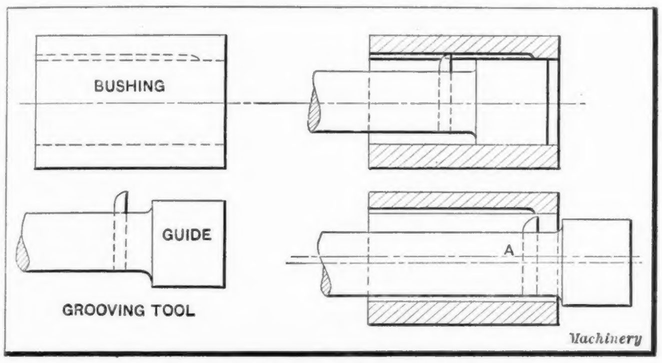
In general, the class of men who use hand-cranks, do not know what good judgment is, and too often use the handles of hand-cranks as seats when tired. To prove the lack of knowledge displayed by men of this class, I will cite an instance that came under my notice. A hand-lever of the walk-around type, with a five-foot lever arm, was used for opening

and closing a valve. One man was all that was needed, but three men were crowded onto the handle to raise the valve. Not knowing that the valve was raised to the full travel, they continued to work until the valve struck a positive stop, and thinking the stop a nuisance, pushed still harder and snapped the chains.

Another good point is to have the handle offset a slight amount; this places the man's body away from the end of the crankshaft, and lessens the liability of jamming it at every turn of the crank. A piece of brass pipe makes a good grip, as exposure to inclement weather will not cause it to split or warp. When it is necessary to use two men on a crank, it is preferable, if possible, to have two cranks placed 180 degrees apart. This gives a much steadier action at the other end than if two men are placed on one crank. C. P. W.

CUTTING OIL-GROOVES IN BUSHINGS

The tool shown in the accompanying engraving is used to cut oil-grooves from one end to within ¼ inch of the opposite end on the inside of the bushings. A good clean job is secured in a very short time. The illustration indicates how the work is accomplished. The tool consists of a piece of machine steel, one end of which is turned to fit the hole in the bushing, this end acting as a guide. The other end



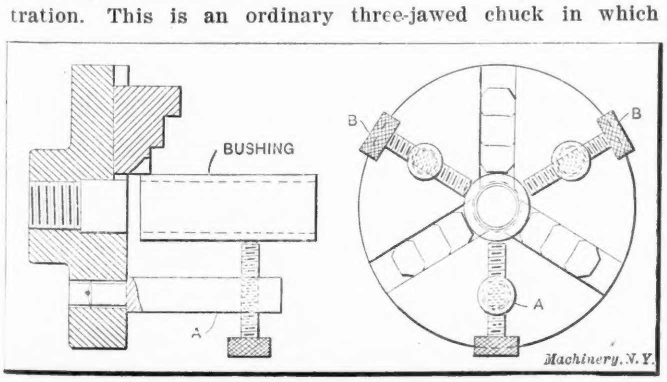
A Convenient Method of Cutting Oil-grooves

is turned smaller in diameter, and in it is inserted the cutter used to cut the groove. Three cuts with three different settings of the cutter were required to complete each bushing. The cutter is made a drive fit in the hole in the arbor. The tool is pushed through all the bushings to be grooved after each setting. The distance from the end of the guide to the cutter determines the distance that the end of the groove will be from the end of the bushing, the illustration showing at *A* how the tool is relieved from the cut before the groove has been cut clear through the bushing. The whole job was done on an arbor press.

Springfield, Ohio. A. J. DeLille

GRINDER CHUCK FOR HOLDING LONG WORK

A chuck which can be used for holding long bushings when grinding them internally is shown in the accompanying illustration. This is an ordinary three-jawed chuck in which



Chuck for Holding Long Bushings when Grinding Internally

three holes are drilled and tapped through the body for holding three studs *A*. Screwed into these studs are three knurled screws *B*, which are used for supporting the work.

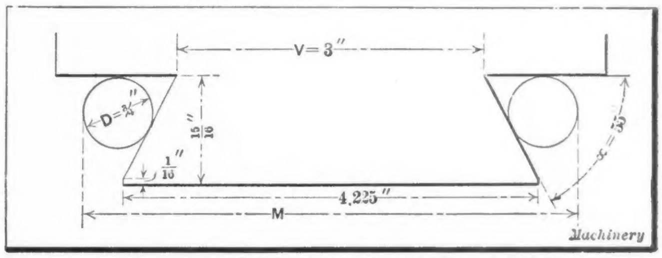
In operation, the bushing to be ground is chucked in the regular way by letting the jaws of the chuck grip ¼ inch from the end, thus leaving sufficient clearance for the wheel to pass through the bushing. The three knurled screws *B* are then brought to bear lightly on the work, so that they will hold the bushing securely without springing it. The outer end of the work can be trued in the chuck by operating these knurled screws. When the studs are not necessary for supporting the work, that is, when the work is not very long, they can easily be removed. William H. Vockell

Cincinnati, Ohio.

FORMULA FOR GAGING DOVETAIL SLIDES

The following rule may be used for finding the dimensions over the wires or plug gages when measuring dovetail slides as indicated in the accompanying illustration:

Add 1 to the cotangent of one-half of the dovetail angle, and multiply by the diameter of the plug gage. Add the



Notation used in Formula for Gaging Dovetail Slides

product obtained to the "vertex" distance of the dovetail. The sum is the required micrometer reading.

Expressed as a formula this rule takes the following form (see illustration for notation):

$$M = (1 + \cot \tfrac{1}{2}a)\, D + V.$$

In the example indicated by the dimensions in the illustration, we find:

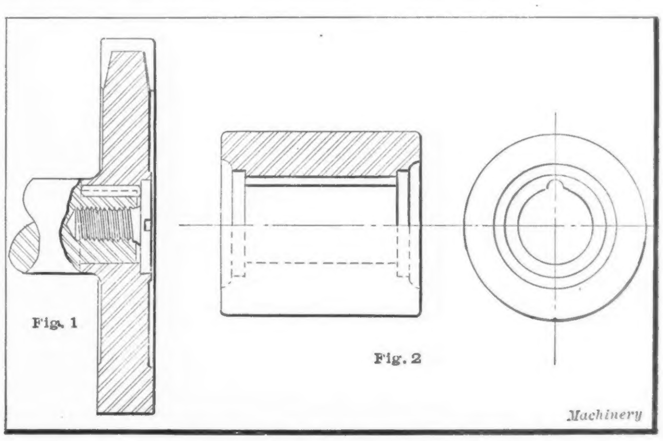
$$M = (1 + \cot 27\tfrac{1}{2}°)\ \tfrac{3}{4} + 3 = 5.191 \text{ inches}$$

The derivation of the formula is based on the first principles of trigonometry, and anyone familiar with this kind of mathematics can easily prove it for himself.

Revere, Mass. Guy H. Gardner

FASTENING SMALL MILLING CUTTERS TO ARBORS

In the article in the February issue, "Device for Fastening Threaded Milling Cutters to Spindle," a very good and satisfactory method is described. In the accompanying engraving is shown a method extensively used in the plant where the writer is employed, for fastening T-mills to arbors, and also



Figs. 1 and 2. Method of Fastening Small Milling Cutters to Arbors

for mounting and using shell mills as end mills. In Fig. 1 a T-mill mounted on the end of an arbor is shown. It is prevented from rotating on the arbor by a round key, and is held in position by the screw in the end of the arbor. This method was adopted after several other methods of constructing T-mills were tried. By making the holes in the cutters of standard size, and using a uniform length of hub, a large range of work can be covered with but few cutters and arbors. For instance,

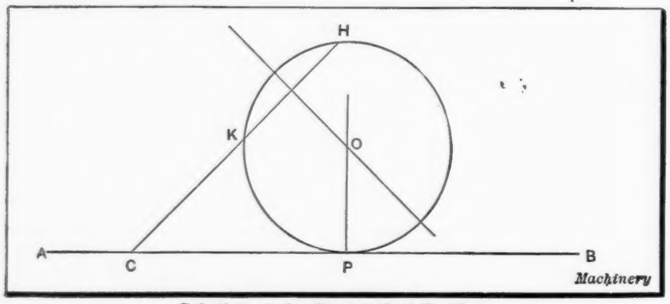
the same cutters may be used on arbors having No. 9, 10 or 11 shanks; in fact, only a few sets of these arbors are used in the plant which the writer has in mind, while a large variety of mills are used, including regular shell mills, made as shown in Fig. 2. These mills are made alike at each end, thus giving a choice of a right- or left-hand mill. They are easier to grind than an ordinary end mill, and last twice as long, there being two ends to dull before grinding is necessary. Of course the arbors on which these shell mills are used are longer than those used for T-mills.

T. Covey

A GEOMETRICAL PROBLEM

In the March, 1912, number of Machinery appeared a brief article by Mr. C. W. Hinman entitled, "A Geometrical Problem." Below is given a solution of this problem which eliminates the construction of a parabola.

As will be remembered, the requirements are to draw a circle that is tangent to line *AB* and that passes through the points *H* and *K*. Draw a straight line through *H* and *K* and let *C* be the point of intersection between this line and the line *AB*; then the point of tangency *P*, is found in accordance with the well-known geometrical proposition that



Solution of the Geometrical Problem

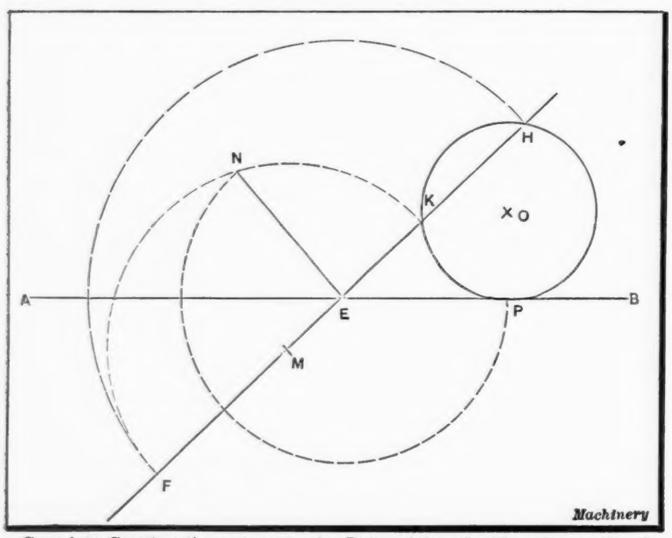
$$CK \times CH = \overline{CP}^2$$

Hence, line *CP* should simply be made the mean proportional between *CH* and *CK*; this determines the point *P*. The required circle now must pass through the points *H* and *K*, and be tangent to *AB* at *P*. The center *O* of the circle is then easily found by means of well-known geometrical methods.

Moscow, Russia. R. Poliakoff

ANOTHER COMMENT ON "A GEOMETRICAL PROBLEM"

In the solution of "A Geometrical Problem" proposed by Mr. C. W. Hinman in the March, 1912, number of Machinery, the draftsman is confronted with the necessity of constructing a parabola before solving the problem. This makes the solution of little practical value to the ordinary draftsman, although it may be of interest mathematically. A simple and practical solution of the problem is, however, possible.



Complete Construction necessary for Determining the Mean Proportional

In the accompanying engraving let *K* and *H* be the two points through which the required circle is to pass, and *AB* the line to which it must be tangent. Draw a line through *H* and *K* and prolong it indefinitely, crossing line *AB* at *E*; make *EF* equal to *EH*; bisect line *KF* at *M*; with *M* as a center draw a half-circle *FNK*, and erect a perpendicular *EN*; then make *EP* equal to *EN*. Point *P* is now the point of tangency, and by any well-known method for describing a circle through the three points, the required circle can now be constructed.

The proof of the accuracy of this method is based on the fact that, according to a well-known geometrical proposition,

$$EK \times EH = \overline{EP}^2$$

If, according to the construction, *EP* is the mean proportional of *EH* and *EK*, this requirement is filled. Now, *EN* is a mean proportional between *EF* and *EK*, or

$$EK \times EF = \overline{EN}^2$$

But *EF* equals *EH*, and *EN* equals *EP*; hence,

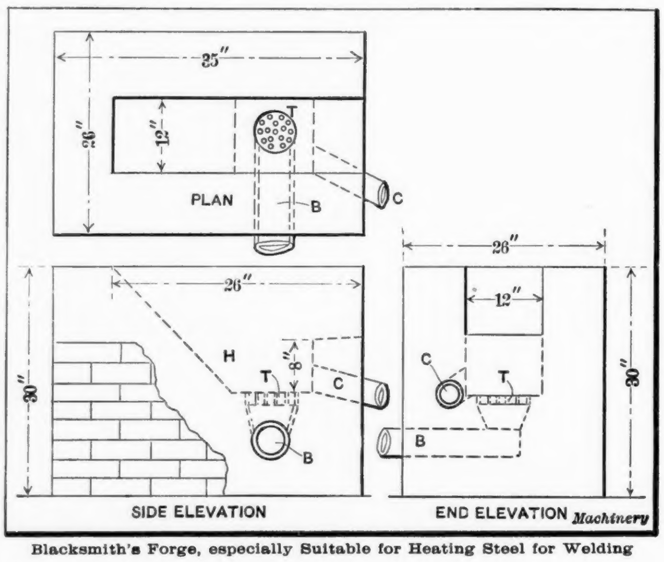
$$EK \times EH = \overline{EP}^2$$

Consequently, *P* is the point of tangency with the circle passing through *H* and *K*, tangent to line *AB*. A. M. S.

[A solution similar to that just given has also been submitted by Mr. George W. Burley, Sheffield, England; Mr. Samuel McAnally, Stratford, Ontario; and Mr. George W. Hammond, Manchester, England.—Editor.]

WELDING NICKEL-CHROME STEEL

The following is offered in reply to C. L. L.'s question in the February number of Machinery, relating to the welding of nickel-chrome steel. There are no physical or chemical reasons why nickel-chrome steel should give trouble in welding in an ordinary forge fire. There may be mechanical reasons for having difficulty with these steels, but these are wholly caused, and can be controlled, by the person doing the welding. Broadly speaking, nickel and chromium increase the susceptibility of the steel containing them, to heat treatment, which includes not only hardening and tempering, but forging and welding as well. It seems sufficient to say that these steels weld as readily as any carbon steels of the same "temper."



Blacksmith's Forge, especially Suitable for Heating Steel for Welding

It is generally recognized by all blacksmiths that the lower the carbon contents of steels, the easier they weld. That this is true is readily seen when two pieces of iron, which are free from carbon, are heated to the proper welding temperature and then brought into contact; they instantly weld perfectly. The carbon steels in general use, and with which the average blacksmith is familiar, usually contain about 0.25 per cent carbon. Nickel-chrome steels are made in grades of 0.08 to 0.15 per cent carbon, and 0.16 to 0.25 per cent carbon, and higher. The grades containing the higher percentages are seldom met with by the blacksmith, as these are generally used for structural purposes, though they too can be welded by carefully heating to slightly lower temperatures than used for carbon steels of the same carbon percentages.

With the lower carbon grades of nickel-chrome steels it can be readily seen from the carbon contents that these should weld without the slightest difficulty. In general, these steels should be heated to 2300 or 2400 degrees F., but the heating

should be done slowly, because of the denseness of the grain and to insure an even distribution of the heat throughout the piece. The forge fire should be clean and of ample volume to completely surround the steel to be welded. Use care that a good bed of clean fire is kept between the tuyere and the steel. See that the air blast does not strike the latter directly, while heating, as under these conditions the steel will burn before the proper welding temperature is reached. More trouble is caused in welding with dirty coal fires than from any other reason.

The accompanying illustration shows a modified blacksmith's forge used for heating small pieces for welding; *B* is the blast pipe, *C*, the cleaning flue, and *T*, a small tuyere perforated with a number of one-half inch holes. The hearth *H* is made eight inches deep and the fire is always kept up to the top of this hearth. This insures a good, clean, clear fire at all times, and keeps the steel to be welded far enough away from the blast to prevent burning. Pea-coke is generally used in a forge of this kind. This forge can also be used for heating high-speed steel for hardening with excellent results. If the directions given are followed carefully, there should be no difficulty whatever experienced in welding nickel-chrome steels. E. D. Allen

Latrobe, Pa.

VALUE OF DIFFERENTIAL OR PLANETARY GEARING

Properly designed and properly made differential or planetary gears offer an excellent means of reducing the speed of rotating shafts. In the summer and fall of 1905 the writer designed a mechanism in which the main shaft made 120 revolutions per minute and was to drive another shaft at 12 revolutions per minute. To accomplish this, a planetary train of four gears was used, one gear of 48 teeth meshing with one of 20, and one of 44 teeth meshing with another gear of 20 teeth. These gears have been in almost constant use for the past six years, and the 20-tooth gears have in that time made over 230,000,000 revolutions. The most remarkable fact about this train is that it has run these six years as quietly as if it were a worm-gear arrangement, and has never given any trouble except once, through an accident, when a loose piece of metal fell into one of the larger gears breaking some teeth.

The gears with 44 and 48 teeth were of cast iron, while the 20-tooth gears were made of machine steel, but not hardened. The satisfaction derived from this drive speaks in favor of the use, in the proper place, of properly constructed planetary gears, as a simple speed reducing mechanism. To give such satisfaction, however, the gears must be properly cut so that they will run smoothly together, and retain the same distance between the centers. The diameters of the gears must be correct to within 0.0005 inch. One particular feature of this job was that the writer cut all of the gears with one gear cutter, cutting all the teeth to exactly the same depth. They were cut with a special cutter. The writer is of the opinion that if the gears had been cut with ordinary involute teeth, they would not have given the same satisfaction.

An improper method of making a planetary gear speed reducing device is to place the larger gears side by side and then make the driving pinion in one piece, so as to mesh with both, its length being equal to the total width of the two gears. This is a poor method even if the two large gears vary only one tooth, because the pinion will not be in proper mesh with both of the gears, and the drive is apt to be noisy.

Springfield, Mass. Francis W. Clough

"PATENTED" ON MACHINES

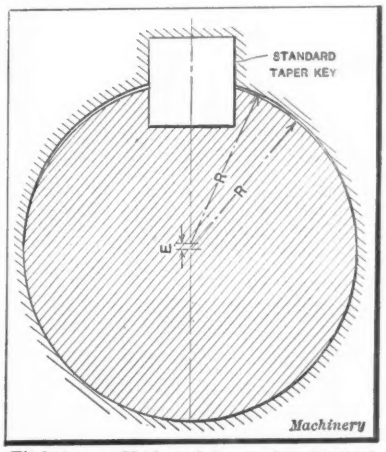
I am interested in your remarks on "Status of Patented on Machines" in the April number. A friend of mine in Wisconsin some years ago began to make slot machines such as were popular for some time for gambling purposes. The machines were going like "hot cakes," and he wanted to prevent anyone from imitating his machines, which were not patented and on which he did not expect to secure a patent. He used a Yale lock to fasten the door through which the owner of the machine was to secure access to the inside of the machine to remove coins, etc. Yale locks are patented. The locks were countersunk in the frames of the slot machines, only the keyholes showing. There was no chance to show the patent notice of the Yale locks, so the following was placed on the machines; "The locking devices on this machine are patented under Nos. ———."

This statement conveyed the impression that the slot machines were patented and avoided any interpretation of the patent law which would apply in marking as patented an article not patented. The impression lasted long enough for the manufacturer of the machine to prevent competition until such a time as the machines were adjudged gambling devices by the police and then destroyed. After that his competitors did not want to make the machines anyway.

Norwood, Ohio. Albert Stritmatter

METHOD OF BORING HOLES IN KEYED PULLEYS

When large pulleys or gears are fitted to shafts in any other way than by a press or shrinkage fit, there must necessarily be some difference in diameter between the bore and the shaft. If a taper key is used, the shaft is always forced to one side of the bore, and the pulley or gear becomes eccentric. In many cases this may not do any harm, but it certainly is of no advantage; and unless the play between the bore and the shaft is small, it is likely to cause trouble. Furthermore, if there is too slight a difference between the bore and the shaft, the wheel will frequently stick, especially if it is to be pulled over a considerable length of the shaft. This condition is especially exasperating when making emergency repairs.



Fit between Shaft and Bore when Method outined is followed

The accompanying illustration shows a simple way of avoiding both difficulties. The idea is not new, but has been used by two or three companies to the writer's knowledge for more than ten years. Nevertheless, the method is one which is not generally known. After the pulley is bored, it is shifted in the chuck or on the faceplate, an amount as represented by *E* in the illustration; then, without changing the setting of the tool, the hole is rebored. The first hole should be exactly equal to the shaft diameter. Then, after the taper key is driven home there will be an exact fit on the lower half of the shaft, instead of a fit theoretically along one line only, which would be the case if the bore were circular, and larger in diameter than the shaft. The main reason for this method of boring the pulley is, however, the ease with which even a big heavy wheel can be put on or taken off.

The exact dimension *E* cannot be given, because it would vary considerably in different shops. It depends on the size of the shaft and the grade of the work. However, the writer would say that on heavy gears, pulleys, etc., 1/32 inch is not too much. There will be an open space between the shaft and the bore on the keyseat side anyway, and it is difficult to see why a 1/32 inch space at the top would be any more objectionable than a 1/64-inch space. The extra cost of this method of boring is small in comparison with the advantages obtained. Next to a press fit this method provides theoretically and practically the most satisfactory means for fitting a shaft to its bore. F. D. Buffum

Ellsworth, Pa.

ROLLING BLUEPRINTS

Trivial as it may seem considerable energy is lost by mechanics, engineers, architects, and others on account of the fact that blueprints are almost invariably rolled with the face

in. A moment's consideration of the subject will convince the least observing of men that such is the case, but why it is so done is unanswerable except that it seems to be intuitive, just the same as putting money inside of a pocket-book instead of outside of it. The reason for putting money in a pocket-book is obvious, but protection in the case of blueprints is fallacious as the back of the paper is as necessary as the face.

The objection to rolling a print with the face in is that it is a very difficult matter to make it lie open properly when unrolled for reference. Weights or thumb-tacks, or four hands are then in demand, when if the print has been rolled face out it may be unrolled and placed on a board or held in two hands without trouble. Try rolling a blueprint both ways and be convinced. You will not be likely again to roll a blueprint face in. C. H. Casebolt

St. Louis, Mo.

[The same reason for rolling blueprints face out applies to the rolling of magazines for mailing. If rolled with the title page out when mailed, the unrolled copy will soon settle down and lie flat on a table with the title page up. Machinery has been mailed for the past few months with the title page rolled out.—Editor.]

DRAWING AN ODD-SHAPED CUP

In answer to the question on drawing an odd-shaped cup in the "How and Why" columns of the March issue of Machinery, the following solution is offered. By this method four operations would be required to complete the drawing of the cup and Fig. 1 illustrates the successive drawing operations. The first operation consists in drawing from the center of the blank a cup-shaped depression 5/8 inch diameter and 1/4 inch

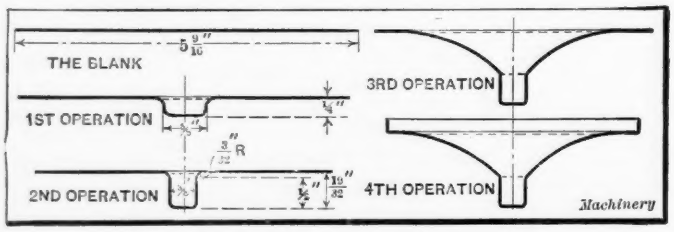


Fig. 1. Results of the Four Drawing Operations

deep, as shown. The die for accomplishing this part of the work is shown in Fig. 3. This die is an ordinary drawing die with a spring blank-holder and needs no further explanation. The second operation consists in drawing the cup-shaped depression to the depth of 1/2 inch, and at the same time reducing

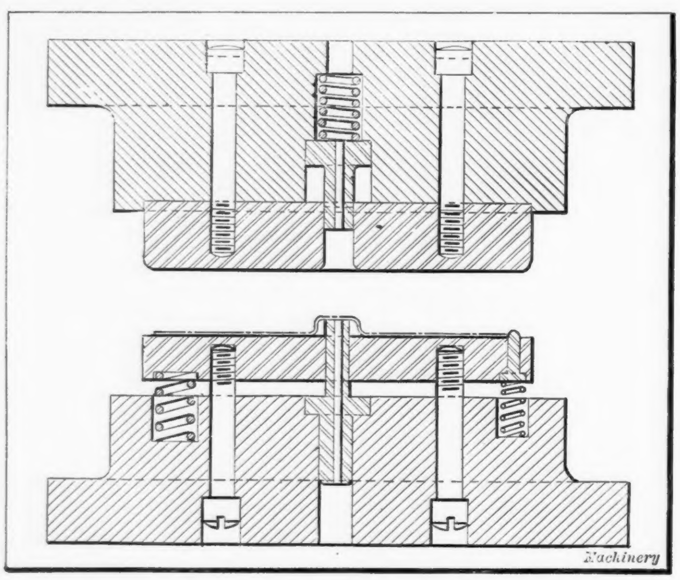


Fig. 2. The Second Operation Die

the diameter to 3/8 inch. The tools for this work are shown in Fig. 2. While this is a somewhat unusual type of die, it has worked out very successfully on similar work. The spring blank-holder should be supported by very weak springs. The third operation consists in forming the central part of the shell by means of the dies shown in Fig. 4, and the same dies are used for the fourth operation of turning up the flange at the outside edge by simply adding the ring shown in Fig. 5.

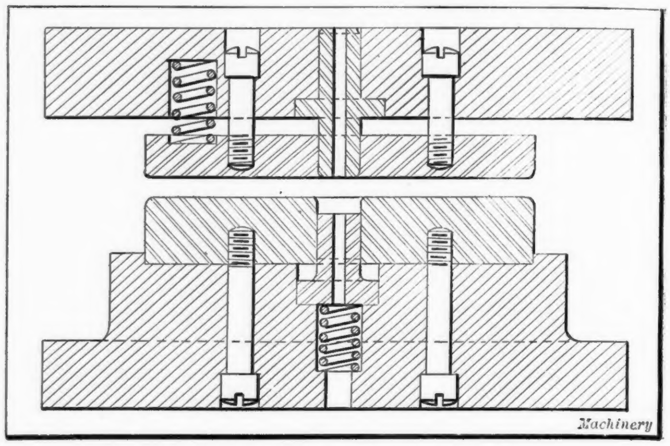


Fig. 3. The First Operation Die

This ring slips on over the lower half of the third operation die, and for this reason it is essential that the outside of this

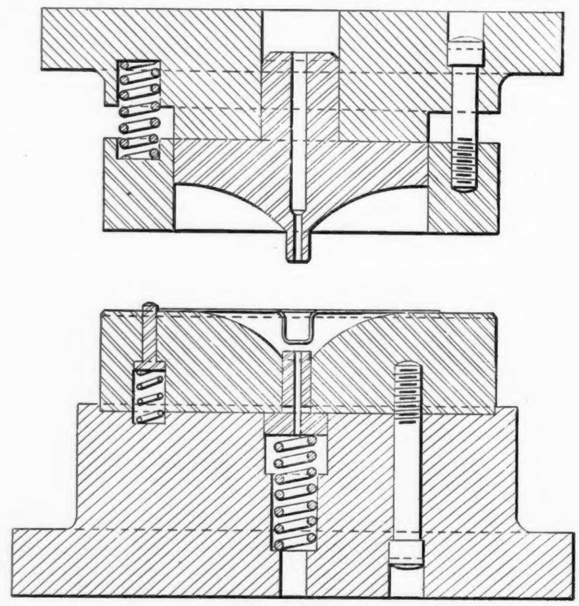


Fig. 4


Fig. 5

Fig. 4. The Third Operation Die. Fig. 5. The Ring used on the Third Operation Die to perform the Fourth Operation

part of the die be absolutely concentric with the depression in this die.

Thomas Alma

REMOVING BURRS FROM METAL PRODUCTS—REJECTED WORK

Referring to the inquiry of D. A. H. in the February number regarding economical methods of removing burrs from metal products, we break up discarded emery wheels and put them into a revolving iron cylinder having internal projections. We put in about an equal amount of sawdust with the broken emery pieces and then the parts from which burrs are to be removed. The tumbling of the parts with the sawdust and emery quickly removes all the burrs that should be allowed on any punched work.

On parts for electrical apparatus that are rejected by inspectors it is our practice to treat them individually so as to bring them up to the standard where it is possible. In a great many cases the stock is of so much more importance than the labor that we find it pays to treat the parts individually.

West Lynn, Mass. Thomas A. Wry

A REVOLVING-HANDLE SCREW DRIVER

The accompanying illustration shows a sectional view of a revolving-handle screw-driver which is found useful for assembling work. It consists of a crank shaped shank *A* made from drill rod, a brass sleeve *B*, a steel thrust button *C*, and a hard wood handle *D*. To assemble these parts the brass bushing *B* is slipped over the shank *A*, after it has been

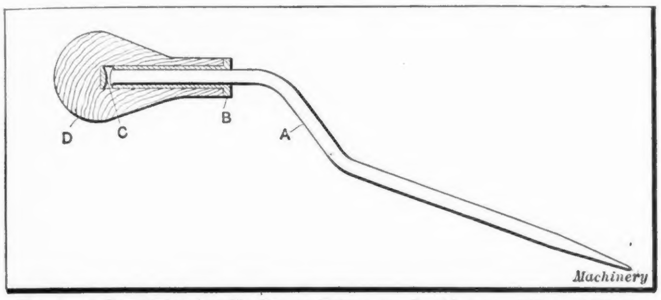


Fig. 1. A Revolving-handle Screw Driver for Rapid Assembling of Work

bent to the required shape; then the shank is upset on the end. Thrust button *C* is now slipped in place on the handle and the brass bushing with the shank in it is forced in. The hole in the handle should be deep enough to leave about 1-64 inch play between the end of the shank and the thrust button.

The screw-driver is operated by simply holding the knob

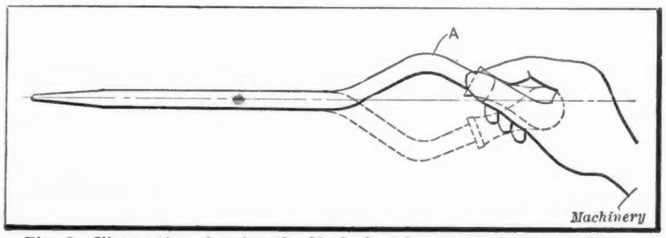


Fig. 2. Illustration showing the Method of Operating the Screw Driver

of the handle against the palm of the hand and gripping the small portion of the shank with the fingers of the same hand and twisting it around without moving the wrist. After a few minutes' practice this screw-driver can be worked with great speed in both directions. J. E. U.

BALL AND ROLLER BEARINGS IN MACHINE TOOLS

In reply to your criticism in the February number of Mr. Henry Hess's remarks on the application of ball bearings to the main spindle of machine tools, it might be interesting to cite the fact that several eminent tool builders in England have already, with apparent success, put them to this use. Messrs. Kendal & Gent, of Manchester, are producing a hexagon turret lathe which takes bars up to 3 inches, the headstock of which is fitted throughout with ball bearings. They claim to have reduced the power consumption per unit of metal removed about 50 per cent. Messrs. Parkinson & Sons, of Shipley, are fitting ball bearings to milling machine spindles. Messrs. Alfred Herbert, of Coventry, are using them on the spindles of automatic chucking machines and turret lathes. This firm, before finally adopting ball bearings for the spindles, gave them a test extending over several years on some of the shop machines. The machines worked satisfactorily under heavy forming cuts.

The type of bearing used in every case is that known as "single track journal," which has, of course, no provision for adjustment. In the writer's personal experience, he has found that if a ball bearing is fitted, no adjustment is needed for the simple reason that a bearing of ample proportion practically does not wear, and ball-bearing makers are now turning out so perfect a product that the clearance between the parts of a journal bearing is only just sufficient to insure free running —not exceeding, at any rate, that of a well scraped bush bearing.

In the case of thrust bearings of the ball type, where thrust is taken by the balls in both directions, it is absolutely unnecessary to provide adjustment. If adjustment is found to be needed, this is only a proof that the proportions have been undercalculated, and the remedy, therefore, is obvious. The initial adjustment should be made in construction by the makers and in such a way that it cannot, by any means, be tampered with by the user.

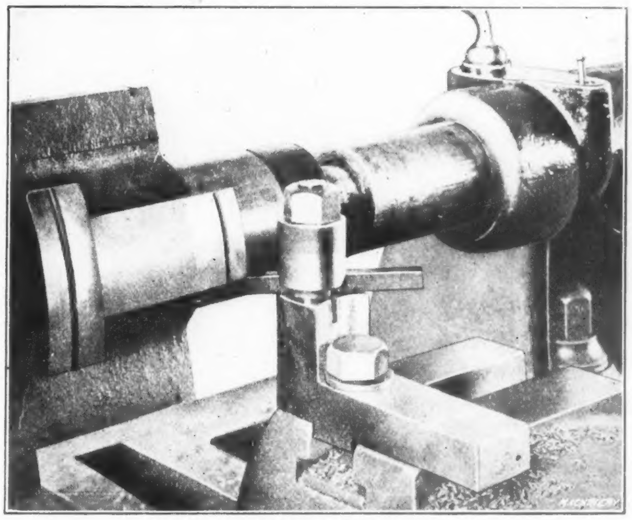
Some months ago the writer designed a lathe headstock of the all-geared type, in which the journal pressures were entirely taken care of by the ball journal bearings, and the end thrusts, by double ball thrust bearings. The body of the headstock formed an oil bath, which was necessary to lubricate the gears. At the same time, the spray from the oil was sufficient to keep the ball bearings in good condition, rendering quite unnecessary the provision of other means for lubrication; in fact, the headstock was entirely without lubricators. In this particular case, the diameter of the spindle would have been excessive for the load and speed, and ball bearings gave a means of getting over a very troublesome proposition.

The writer has a very strong conviction that in ten years, so far as machine tools are concerned, practically every bearing of importance will be a ball bearing. The days of bronze and babbitt are numbered. A fifty per cent reduction of the power bill is not to be lightly considered, particularly in these days of coal strikes.

A method successfully applied in a grinder head was the fitting of a long bush behind the ball bearing, this bush having a little more clearance than the balls in the ball bearing. The idea was that the solid lubricant with which the shaft in the bush was oiled would act as a deterrent against vibration, for before vibration could take place, the grease would of necessity have to be squeezed out. A SUPPORTER OF HENRY HESS

A TOOL-HOLDER FOR THE LATHE

The accompanying illustration shows a tool-holder which holds square turning tools or cutting-off blades made from high-speed steel. The holder consists of a stud held in the L-block which is fastened to the cross-slide, as shown. The cutting tool is retained by a collar, which, in turn, is acted upon by



A Lathe Tool-holder of Rigid Construction

a nut. As can be seen, this holder is provided with a slot in which cutting-off blades can be rigidly held. Another good feature about this holder is that there is practically no overhang at all, thus enabling heavy cuts to be taken without chattering. CHARLES K. TRIPP

West Lynn, Mass.

PACKING BOX NAILS

I have just seen what seems to be an improvement in the use of packing-box nails—*viz.*, the employment of paper disks about ¼ inch thick under their heads. These disks or washers are used in order to lessen the jar on the contents of the box, and to prevent damage to the box itself during transit. When opening, the ordinary pliers or the special nail-pulling devices draw the nails without mauling the box cover. The disks are furnished perforated ready for use.

Dresden Germany ROBERT GRIMSHAW

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

ORIGIN OF COTTER-PINS

A. C. C.—I am desirous of securing information in regard to the origin of the use of cotter-pins as well as the derivation of the word itself. How far back does the use of cotter-pins date? In what country did they originate, and wherein lies the significance of the word cotter-pin?

This question is submitted to the readers.

DIAMETER OF STEEL BALL

A. J. C.—Please give a formula for solving this problem: If a steel ball 0.718 inch diameter weighs 380 grains, what must the diameter of a ball be to weigh 383 grains?

A.—The cubic contents of spheres are to one another as the cubes of their diameters. Therefore, the relation between two balls is expressed by the proportion $x^3 : y^3 = a : b$, in which x and y represent the diameters of the balls and a and b the given weights. From this we obtain the expression $x^3 : 0.718^3 = 383 : 380$; clearing for x yields

$$x = \sqrt[3]{\frac{0.718^3 \times 383}{380}} = 0.720 \text{ inch},$$

the required diameter.

PORTABLE BORING BAR

J. H.—I am foreman of the machine shop of a large factory manufacturing tinware and sheet metal goods, and have a number of stamping presses to keep in repair. I have now the job of repairing a broken crankshaft. The bearings for the shaft are badly worn and need reboring. I wish to rig up a boring bar and bore out just enough to true up the bearings, which are about 3 inches diameter and 18 inches apart. Can you refer me to the design of a simple boring bar that can be rigged up for the purpose of boring out the holes in the press frame while in position?

A.—The situation described is typical of many repair jobs requiring the reboring of two or more holes dead in line. The regular portable boring bars designed for reboring engine cylinders are generally too heavy and cumbersome for machinery repair work, and even if a given situation is such that an an engine boring bar could be used, the cost and time required to obtain one are generally prohibitive for emergency repair work. Suggestions are invited describing simple portable means which can be provided by almost any machine shop for efficiently boring holes from 2½ inches diameter up, and employing a traversing bar or traversing tool head.

DESIGN OF DROP-FORGING DIE

A. C. F.—I desire to make drop-forging dies for the piece shown in Fig. 1. This piece is to be a steel forging, and the

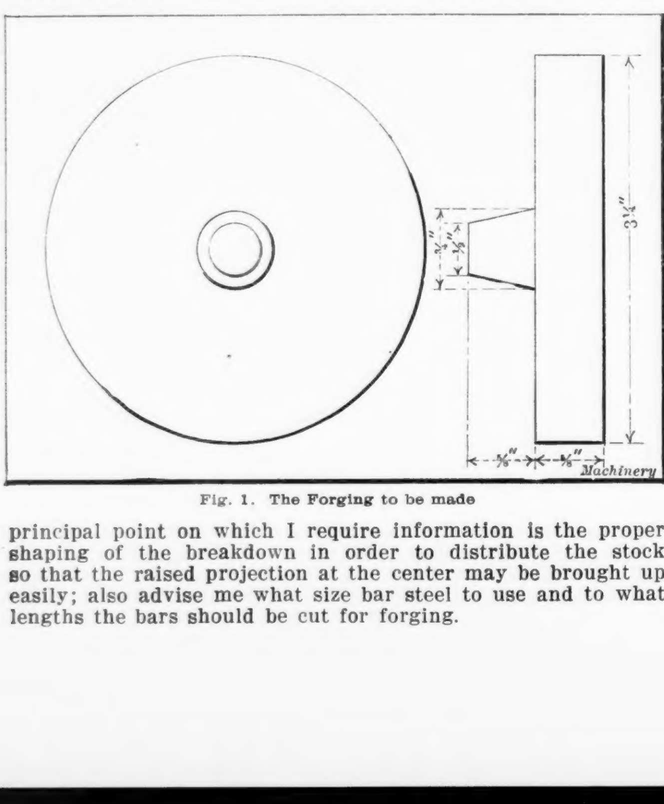


Fig. 1. The Forging to be made

principal point on which I require information is the proper shaping of the breakdown in order to distribute the stock so that the raised projection at the center may be brought up easily; also advise me what size bar steel to use and to what lengths the bars should be cut for forging.

Answered by J. W. Johnson, Revere, Mass.

A.—The drop-forging of the piece shown can be easily accomplished by making the breakdown in the manner shown in Fig. 2. The outline of the breakdown should be laid out about ⅛ inch smaller than the finished forging is to be, and the corner should be well rounded at the parting line. The face of the breakdown should be wider than it is ordinarily made, in this instance being two inches wide in order to

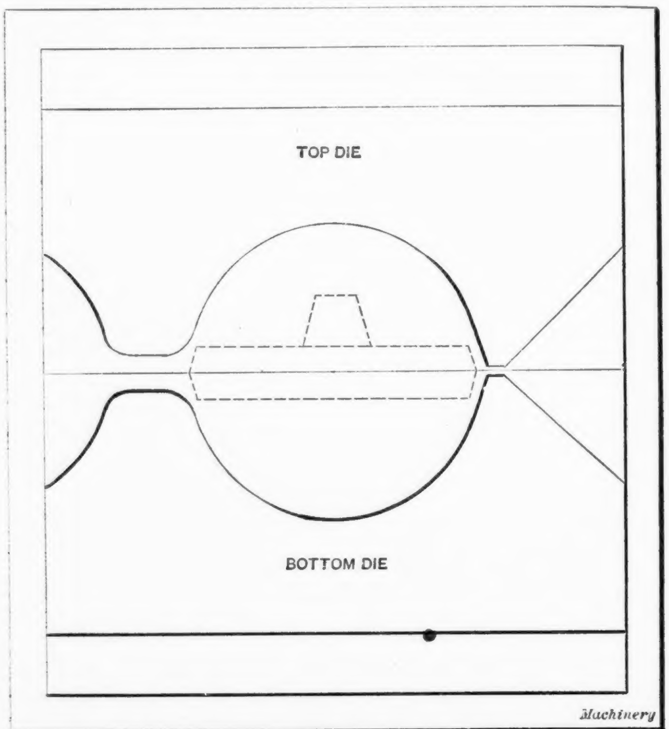


Fig. 2. Showing the Outline of the Breakdown

facilitate the rapid breaking down of the stock. In cutting the face impression in the die it should be remembered that the impression that is to form the projection on one of the faces of this piece should be cut in the upper die on account of the fact that the metal is more easily forced up than down into a depression.

The dimensions of the stock should be very close to 3 inches by 1 inch, and in cutting the bars for forging, the lengths should be just long enough to make four pieces. The first piece forged will leave the bar in the condition shown in the upper view in Fig. 3. It will be noticed that the gate to the breakdown is cut away so that one-half of the outline of the

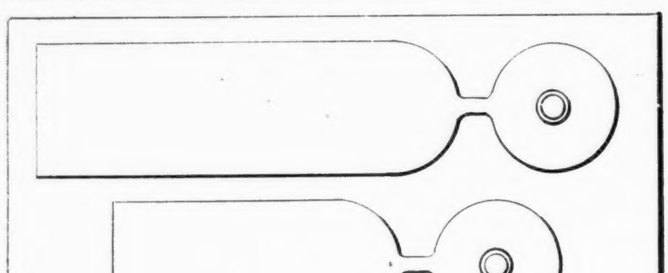


Fig. 3. The Way the Bars are forged

second piece is forged at the same time as the first. At the completion of the second forging the first forging has been cut from the bar, the second forging formed, and half of the third forging outlined. After completing the third forging, which will leave the bar in the condition shown in the lower view in Fig. 3, the stock is reversed and held in a pair of tongs which grasp the forging itself, and in this manner the last forging is finished.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE FELLOWS HELICAL GEAR SHAPER

Spur gears with helical teeth have long been used in Europe in place of ordinary straight-tooth spur gearing. They are also coming largely into use in this country, particularly for automobile engine gears. The advantage claimed for them is that they run more quietly than old-fashioned spur gears. The

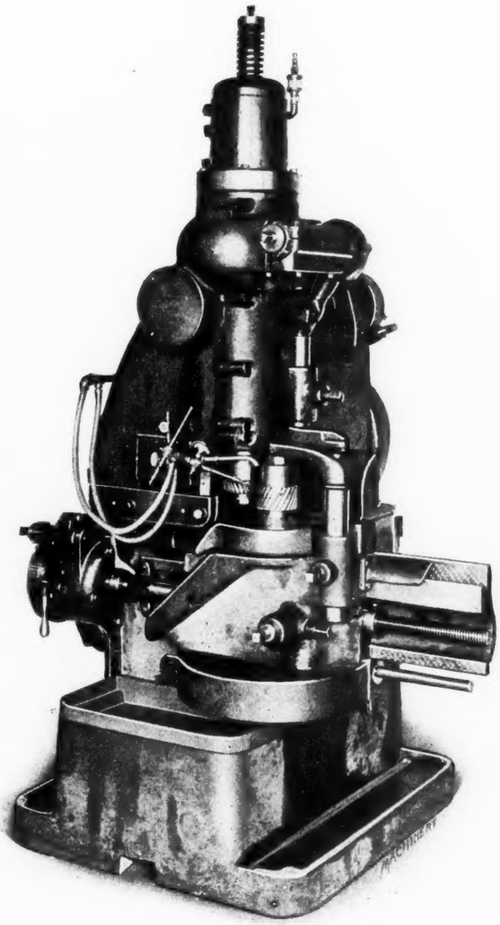


Fig. 1. Helical Gear Shaper built by the Fellows Gear Shaper Co.

difference in the action of the two forms is this: With the spur gear the tooth makes contact with its mate instantaneously along the full width of the face. With helical-tooth gears, on the other hand, the teeth do not come into engagement with each other for the full length at once. Contact is made at one end of a pair of teeth first, then a little further in from the end, then a little further still, and so on to the other end of the tooth; and by this time the next pair should be making contact at the front end. Thus it comes about that the teeth are making contact all the time and are going out of contact all the time, the engagement being continuous instead of intermittent. This tends to make the action smooth and regular.

The Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt., some time ago began a series of experiments and investigations on the problem of a simple and accurate process for cutting these helical gears. As the result, a helical gear shaper and a hardened and ground helical gear shaper cutter, have been produced, which extend the accuracy and output of the gear shaper process, to the cutting of helical gears.

Principle of the Helical Gear Shaper

The principle of the shaper's operation is identical with that of the regular gear shaper for spur gearing. Fig. 3 shows a helical gear of steel or other metal rotating in engagement with a blank made of putty, wax or some other plastic substance. It is evident that the teeth of the generating gear will mold, in the plastic blank, teeth of the proper shape to engage with it or with any other gear of the same pitch and helix angle. If the plastic blank could then be hardened, it would be a serviceable gear for use in an actual machine. The practical problem, of course, is to adapt this molding process to the cutting of hard metal gears. This may be done as shown in Fig. 4 where the generating gear is of high speed steel with the tooth outlines sharpened to a cutting edge. This gear, or gear-like cutter, is rotated with the metal blank as if they were in mesh with each other the same as in Fig. 3. In addition, the cutter is given a cutting stroke with a helical motion, which sweeps its cutting edge through the exact space occupied by the tooth surfaces of the generating gear in Fig. 3, and the cutter generates helical teeth in a metal blank, in exactly the same way that the gear molded teeth in the plastic blank; any gear so generated and having twelve teeth or more, will mesh with any other gear of twelve teeth or more, cut by the same cutter.

Special Features of the Machine

Two views of this new helical gear shaper, are shown in Figs. 1 and 2. The only change in the design, as compared

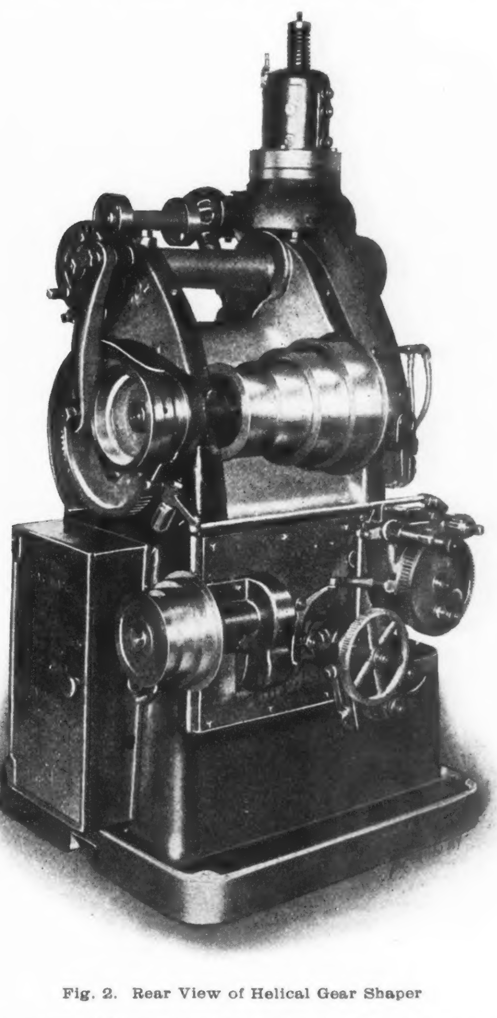


Fig. 2. Rear View of Helical Gear Shaper

with the gear shaper previously built by this company, is the provision of a helical guide for giving the twisting motion to the cutter spindle as it is reciprocated up and down for the cutting and return strokes. Fig. 5 shows the cutter spindle, guide and cutter removed from the machine. The guide, as may be seen, is a solid block of cast iron, which is planed by special machinery to a helix of the proper lead. The mating guide (see Fig. 6) is seated in an enlarged hub bolted to the face of the index wheel. It is of large dimensions and has planed and scraped helical surfaces. It is split in the middle

and is provided with an endwise adjustment for taking up the wear. The bearing surfaces are so generous, however, that the wear is negligible. The location of the helical guides in the machine is plainly shown in Fig. 8, where the internal member is seen projecting beyond the hub in the upper index wheel.

This guide mechanism is worthy of particular study. Change gears have been invariably employed for obtaining the desired helix angle in previous designs of commercial helical gear-cutting machines. This is convenient where constant changes

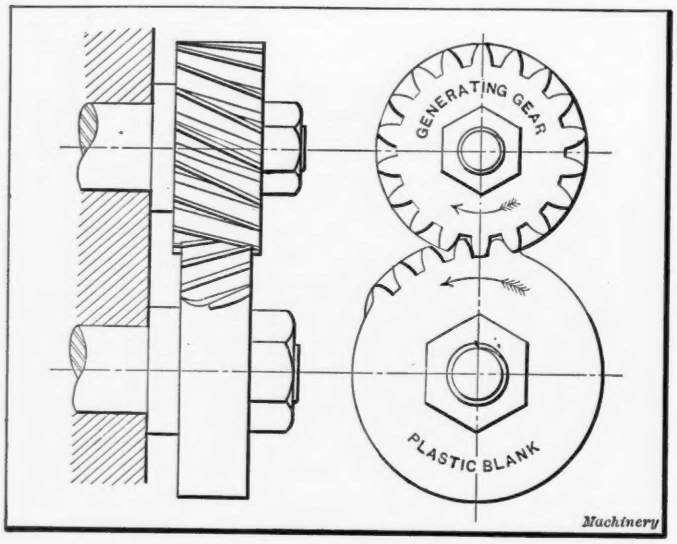


Fig. 3. Diagram illustrating Molding-generating Principle

in helix angle are to be made, but it is a disadvantage as a manufacturing proposition. The control of the motion is elastic and complicated. Furthermore, the change gears usually have to be reset for each new number of teeth cut, even though there may be no change in the helix angle, and often the machine is so designed that a change of feed cannot be made without a re-calculation of the helix change gears. The result is that it may be impossible to do more than approximate the desired helix angle, so that two gears of different numbers of teeth will be found to have slightly different helix angles when the attempt is made to run them together, this being due to approximations in the gearing for the two cases that were different in amount or direction.

With the helical guide mechanism of the helical gear shaper, the cutter is directly connected through the spindle to the

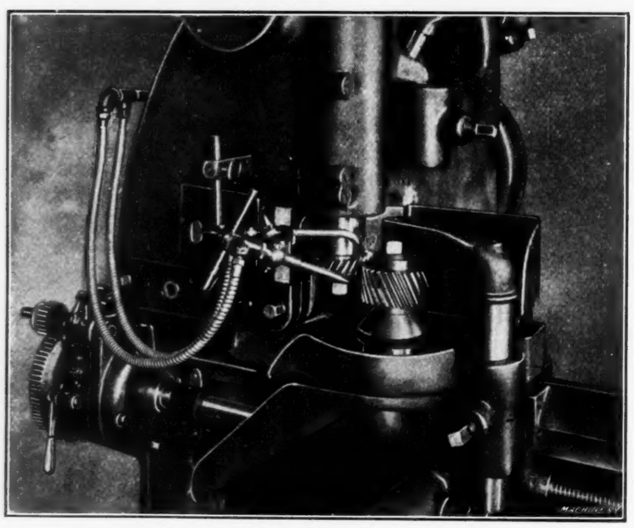


Fig. 4. Detail View of Helical Gear Shaper

guide which determines the lead of the helix. The control of the motion is direct, rigid and positive. The mechanism is independent of the feed, cutting stroke, indexing or any other function of the machine. It is made of the exact helix desired in the first place and never changes. By means of special machinery, any number of guides of any angle can be made, all exact duplicates of each other. The helix angle of the gears likewise never changes, so that this source of error is removed.

Only ten or fifteen minutes is required to change cutters or guides when changing from one helix to another or from a right-hand to a left-hand gear.

A pair of helical cutters used on this machine, is shown in Fig. 7. Like the straight, spur-gear shaper cutter, the helical cutter is hardened before finishing the tooth outline, so that all error from change of shape in the fire is avoided; and it is ground to shape by a generating process after hardening. Every curve on these cutters is a generated curve that is not copied in any way and is formed without the use of templets or master tools. With original curves generated in place on the cutter after hardening, great accuracy is secured.

General Description of the Machine

Aside from the special features previously referred to, the machine is practically a No. 3 Fellows gear shaper of the well-known design. The machine is naturally divided into the following parts: The cutter drive; helical guides; relieving mechanism; index and feed mechanisms. The separate sections will be described briefly.

The cutter drive is operated from the four-step cone pulley seen in Fig. 2. A pinion at the rear end of the cone pulley shaft meshes with a large gear shown at *A* in Fig. 9, which is provided with a graduated crank slot for crankpin *B* operating connecting-rod *C*. The upper end of *C* is pivoted to a wrist-pin

Fig. 6. Mating Helical Guides for Cutter spindle

Fig. 5. Cutter-spindle and Helical Guide

Fig. 7. Helical Gear Cutters

in casing *D* which has bearings for worm *E*. This worm engages worm-segment *F* keyed to rock-shaft *G*. The rock-shaft at its other end carries spur gear segment *H* meshing with rack teeth cut in spindle sleeve *J*, Fig. 11. By means of these connections the cutter spindle *K* and cutter *L* are reciprocated. Adjustment of crankpin *B* in the graduated slot, adjusts the length of the stroke to agree with the graduations. The turning of worm *E* adjusts the position of the stroke to agree with the location of the face of the gear being cut, and screw *Y* clamps this adjustment.

The helical guides, illustrated separately in Figs. 5, 6 and 8, are shown in place in Fig. 11. The fixed guide *M* is seated in the extended hub *N* of the upper index wheel *O*. The movable guide *P* is keyed to cutter spindle *K*. Guide *M* is split into longitudinal sections adjustable on each other by means of screw *Q*. This allows the adjustment to give the proper closeness of fit.

The relieving mechanism operates as follows: Crank gear *A* is keyed to shaft *R* which extends through to the front of the machine where it carries a double-throw cam *S*. Cutter spindle *K* and all the attached mechanism is mounted in the head casting *T* which, as shown most plainly in Fig. 9, is free to swivel through a short arc about the axis of shaft *G*. At the beginning of the cutting stroke, cam *S*, bearing on roll *W*

(see Fig. 11), throws this cutter head forward into the position shown for cutting. On the return stroke, the cam bears against spring support roll *V* on the left, swinging head *T* free and relieving the cutter from the work. On the cutting stroke, the head is swung against positive stop *W* which brings it always to the same position.

As explained in connection with Figs. 3 and 4, the cutter

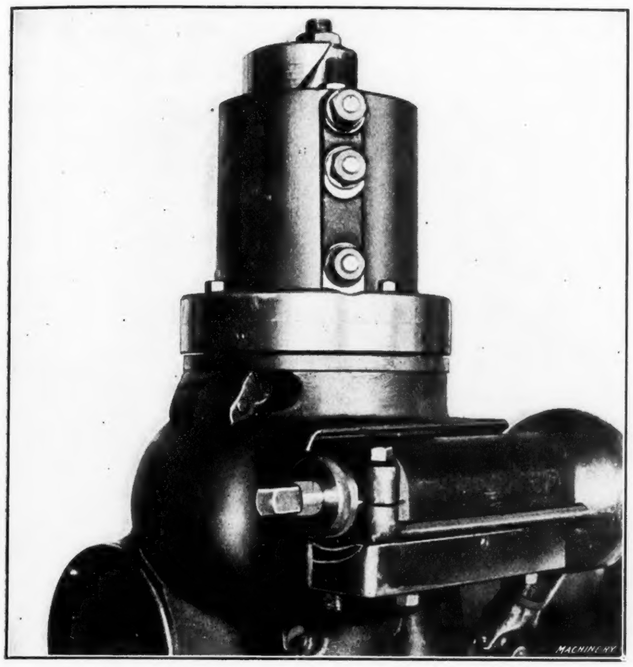


Fig. 8. Detail View of Hub containing Helical Guides

and work are revolved in mesh with each other as if they were a pair of gears. Index wheel *O* for the cutter, and the work index wheel, revolve continuously during the cut, a single revolution of the latter sufficing to complete the work in ordinary cases. They are connected by change gears set for the desired number of teeth.

Four points should be noticed with reference to this index motion: First, it is continuous, steady and slow in movement; second, there is but one revolution per cut, which greatly increases the life of the index mechanism; third, the index

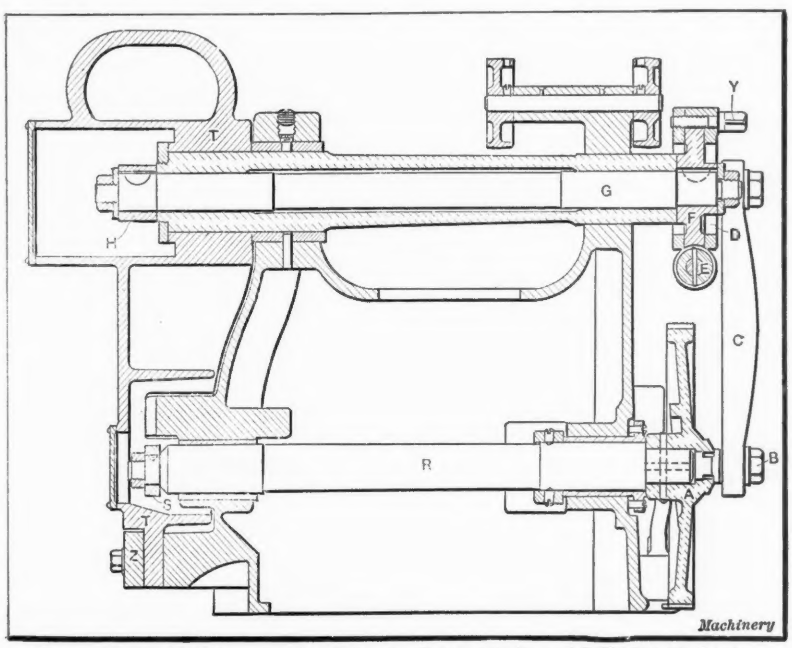


Fig. 9. Vertical Section, showing Drive for Cutter-spindle and Relieving Mechanism

worms revolve so slowly that it is possible to make them self-locking so that the helical thrust of the cutter does not disturb their connection; and fourth, the index mechanism is independent of either the cutter drive or helix mechanism, and is thus free from the irregular action of the former or the complication inherent in the usual design of the latter.

The standard reverse taper work arbor of the gear shaper is retained, thus tying the work, arbor and spindle into a solid whole and giving the entire structure great rigidity. As shown also in Figs. 1 and 4, an outboard support is provided for the work arbor as well as a work support clamped directly to the main frame of the machine. These provisions hold all work firmly, support it against the thrust of the cutter, and permit the machine to "get out" of the cutter all there is in it. Two heavy streams of oil are directed on the cutting edge, cooling the tool and giving a fine, smooth finish on steel work.

The feed mechanism is identical with that of the regular gear shaper. It comprises the rotary motion for the index mechanism, together with means for feeding the cutter in to depth at the beginning of the cut and stopping the feed when the cut is finished. It is entirely automatic in its action.

The double-cut mechanism furnished with every machine, is invaluable when the coarseness of the pitch or the hardness of the material makes it necessary to take a roughing and a finishing cut. The adjustment of a clamp-screw in a graduated slot, determines the amount of stock left for finish.

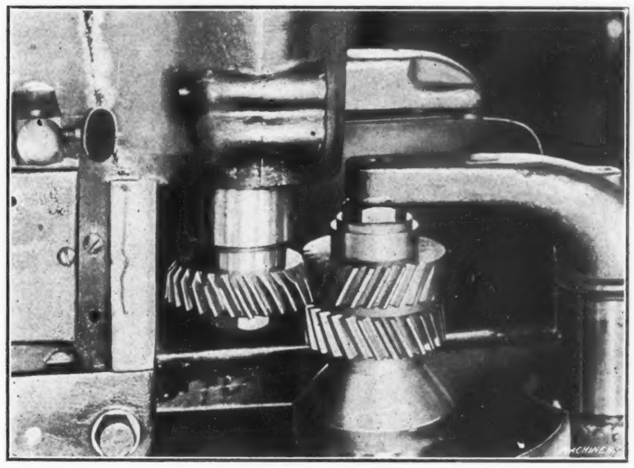


Fig. 10. Cutting a Herringbone Gear

When set for the double cut, with the feed thrown into operation, the following sequence takes place automatically: First, the cutter is fed in to roughing depth. The work then makes one full revolution with the cutter at roughing depth. The cutter next feeds in to finishing depth, and the work makes one full revolution at this depth. Finally, the feed is stopped and a bell rings to call the operator.

Cutting Special Forms of Helical Gearing

The helical gear shaper, like the spur gear shaper, will cut teeth in to a narrow recess. It is therefore easy to cut teeth to a shoulder or to cut cluster-gears with two or more diameters on the same piece. This same feature makes it possible to cut solid, double helical or herringbone gears. With this design of gearing, it has been necessary hitherto to leave a wide space between the two sections for the cutter to run out into, or else the gear has been made in two pieces which are cut separately and fitted and fastened together afterwards. One of these expediencies wastes space, the other time. With the helical gear shaper, a herringbone gear can be made in one solid piece with a narrow groove between the two sections. One-quarter or five-sixteenths inch will do, depending on the pitch or helix angle. The teeth are cut in to this narrow recess from either side. Fig. 10 shows such a gear with the right-hand teeth already formed, and the cutter at work on the left-hand teeth. Where the mating gear is to be cut in the same way, a simple locating fixture brings the teeth on each side of both gears, into position so that a full bearing is obtained on each side of the recess.

Specifications of No. 30 Helical Gear Shaper

The maximum capacity of this machine for cutting helical gears is as follows: Outside diameter, 18 inches; face width, 4 inches; diametral pitch in cast iron, 6; diametral pitch in

steel, 8. It can also be arranged for cutting regular external spur gears, having a maximum outside diameter of 24 inches; face width, 4 inches; diametral pitch in cast iron, 6; diametral pitch in steel, 7. The strokes per minute are 45, 64, 100 and 140. The strokes per inch of pitch diameter of the gear blank are 216, 286, and 418.

In the construction of the machine, particular attention is paid to such vital parts as the index wheels and worms, guides, cutter ram, work spindle, bearings, etc. The materials used are carefully selected for the service required of them. The cutter spindle is hardened and ground. The fast running bearings are lined with phosphor-bronze.

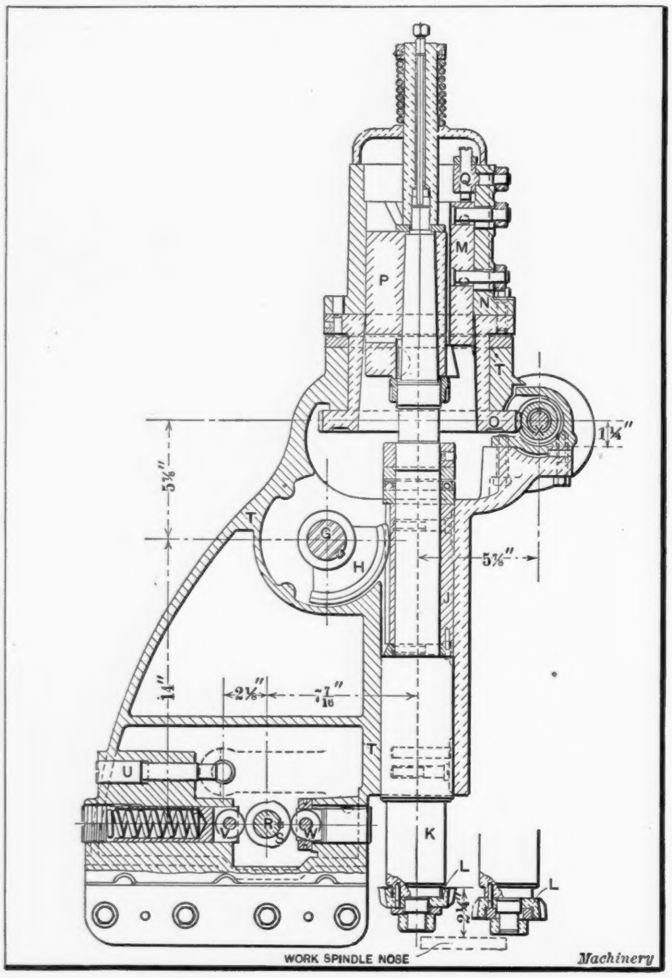


Fig. 11. Section through Cutter-spindle

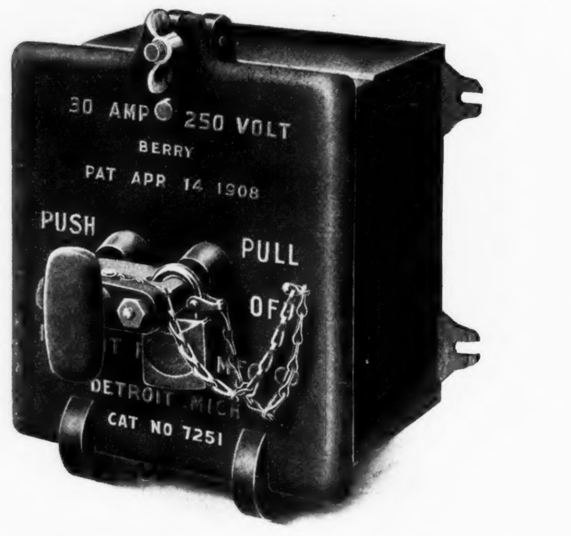
In addition to the machine, the following equipment is furnished: Oil pump and all connections; flexible tubing; two oil nozzles; countershaft complete with tight and loose pulleys; change gears for spacing all numbers of teeth from 12 to 50, and from 50 to 450, excepting the prime numbers and their multiples; one pair of right- and left-hand helical guides of any helix angle specified, up to 30 degrees; all necessary wrenches, etc.

DETROIT SWITCH WITH SAFETY LOCK

Those who read Professor Hutton's article in the April number on the "Prevention of Industrial Accidents," will recall the reference to a safety lock for electric switches, to prevent the unauthorized closing of a switch when repairs are being made along some part of the circuit. The Detroit Fuse & Mfg. Co., 1400 Rivard St., Detroit, Mich., has just brought out an "ironclad" fused switch which is equipped with a padlock for locking the switch in the "off" position, to prevent a circuit from being closed at the wrong time.

The switch is operated by means of a plunger-actuated mechanism with rods projecting through the cover of the box. This mechanism is controlled by a handle on the outside of the switch, and it carries the fuses. The mechanism is attached to the inside of a rubber-gasketed hinged door, and the fuses may be replaced by opening this door. All current-carrying parts are "dead" when the door is open, and the "live" connections are all at the bottom of the switch box, so that it is impossible to make accidental contact with them.

The cover of the switch can be clamped shut by an eye-bolt and wing-nut which engages lugs as shown. A drilled rivet is fastened to the cover, and by running a car seal through this rivet and a hole in the wing-nut, the switch can be sealed to prevent tampering with the fuses. By means of the padlock and clamp shown, the box can also be locked in the "off" position. This feature makes the switch ideal for the control of elevators, special machinery or any electrical service where it is desirable at times, to prevent an unauthorized person from closing a circuit. When repairs are being made to a motor, power circuit or lighting circuit, the one making them can lock the switch in the "off" position and secure absolute protection. The padlock and clamp are attached to the switch cover by short brass chains.



Switch with Padlock for Locking it in the "Off" Position

POWERFUL HYDRAULIC JACK

The United States government has recently purchased from the Duff Mfg. Co., of Pittsburg, Pa., a hydraulic jack capable of lifting a load of 500 tons. This jack is to be used in the Washington Navy Yard. It is of the independent pump type and is composed of two separate parts, one of which contains the water reservoir with its pump chambers, and the other the ram or lifting mechanism.

Duff-Bethlehem 500-ton Hydraulic Jack

Flexible copper tubing capable of withstanding a pressure of 10,000 pounds per square inch, connects the two members as the illustration shows. With this arrangement, the ram can be placed in any position where there is room enough for it, while the pumping mechanism can be located at a sufficient distance to allow the operator plenty of working room.

The pump is an improved duplex type, providing an accumulative stroke on the upward motion of the pump piston, and

a working stroke on the downward movement. The pump is so arranged that a light load can be lifted five times as fast as a heavy load. This differential speed is automatically spring controlled, and requires no regulation of valves by the operator. The high speed is used for loads up to 35 per cent of the jack's capacity. In lifting loads greater than 35 per cent of the total capacity, the spring controlled valve automatically opens at the predetermined pressure per square inch, and the pump becomes single acting, working on the down stroke only.

Another feature of this jack is the gage, which shows the exact lifting pressure that is being applied. This gage acts as a scale and registers in tons the weight that is being lifted. The jack is simple in construction and has no parts to get out of order.

CLAMPS FOR MACHINE TOOLS

The clamping of castings or forgings to the table of a planer, milling machine or other tools, frequently requires more time than the actual operation of machining the work. Furthermore, a great deal of unnecessary time is often consumed

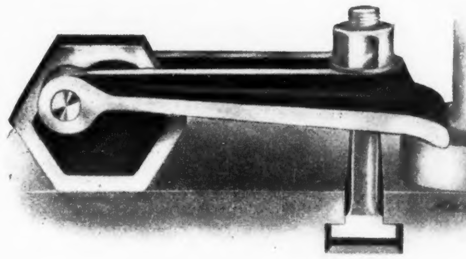


Fig. 1. Clamp Eccentrically Pivoted to Hexagonal Block

because of the lack of proper clamping facilities, as every machinist knows. Schuchardt & Schütte, Cedar and West Sts., New York, have placed on the market the different styles of clamps shown in Figs. 1, 2 and 3, which are designed to reduce the time required for setting up work.

The construction and application of these clamps is so clearly

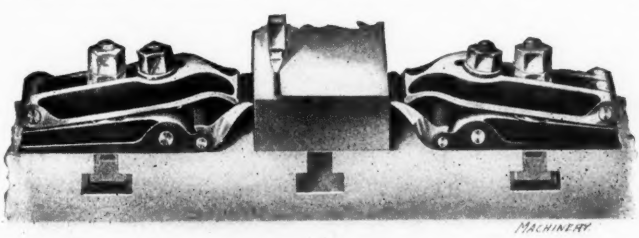


Fig. 2. Type used for Side Clamping

shown by the illustrations that a description is scarcely necessary. The type illustrated in Fig. 1, has a clamp or claw which is pivoted eccentrically to a hexagon block, with the advantage that six different heights may be obtained by simply rotating this block. The design illustrated in Fig. 2 is intended especially for side clamping, whenever the nature of

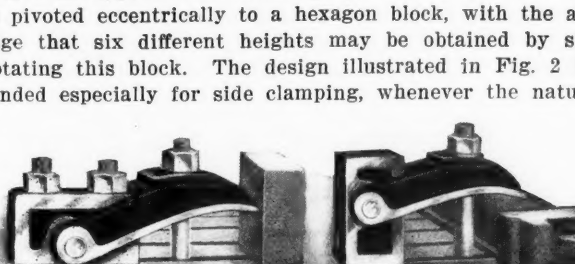


Fig. 3. Combination Clamp for Side and Top Clamping

the work is such that clamps on top would interfere with the movement of the tool. This clamp has two bolts, one of which holds the base while the other tightens a hinged upper member which wedges a hinged claw at the end against the side of the part to be machined. The clamp illustrated in Fig. 3 may be used for side clamping, as indicated to the left, or for top clamping as shown in the right-hand view. This clamp is, in some respects, a combination of the two types previously referred to. The outer end of the clamp is pivoted to a rectangular packing block, in such a way that four different heights are available. These clamps are made in a number of different sizes.

MAGNALAMP FOR MACHINE TOOLS

Operators of machine tools frequently have trouble in adjusting an electric lamp so that the light falls on the right spot. The device illustrated in Fig. 1 is designed to overcome this difficulty, as it can be attached to the machine (as shown in Fig. 2) or work by means of an electro-magnet which con-

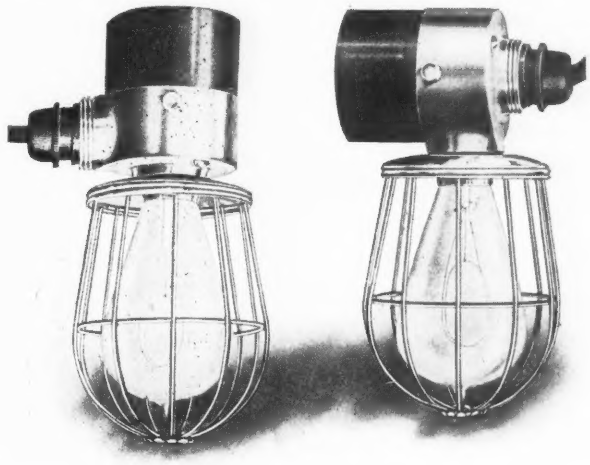


Fig. 1. Electric Light with Magnet for Attaching it to Machine or Work

tains an ordinary incandescent light bulb. It can be applied to iron, steel or any structure that is entirely or partly composed of iron and steel, and the magnetism causes it to stick tight enough to withstand considerable pull. The light bulb extends either from the end of the cylindrical magnet, as shown in the view to the left, or radially from the side, as indicated in the right-hand view, and its position can easily be changed. The same current supplies the lamp and magnet, although the latter consumes a very small amount of energy. The current is controlled by a quick-acting switch operated by a knurled disk which forms the central pole-piece of the magnet. When this knurled pole-piece is turned in a clockwise direction, the switch is opened or closed with each snap. This switch cannot be operated when the magnet is in use. After the current has been turned on and the lamp is lighted, the magnet can be de-energized (so that the lamp may be placed or removed) by pressing the little push button seen extending from the side of the casing above the magnet. By releasing this button, the magnet is instantly brought into service again. After the lamp has once been lighted, it remains lighted, irrespective of whether the magnet is energized or not; consequently, it is never necessary to be without light.

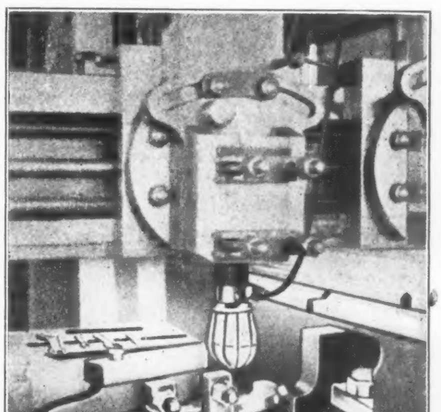


Fig. 2. Magnalamp attached to Planer

This lamp should be supplied with direct current, and it is furnished for the two standard voltages of 110 and 220 volts. This lamp is also supplied with a counterbalance device when it is to be used as a permanent lighting fixture. With this equipment, it serves as an ordinary drop-light when not at-

tached magnetically, and it can be quickly adjusted to the required height. The magnalamp is made by the Sachs Laboratories, Inc., 103 Allyn St., Hartford, Conn.

LODGE & SHIPLEY HEAVY FORGE LATHE

The Lodge & Shipley Machine Tool Co., Cincinnati, O., has recently designed a lathe for taking very "heavy" cuts in connection with the rough turning of shafting and forgings. The power and cutting capacity of this machine is shown by a recent performance, which is said to be safely within the capacity of the lathe for continuous service. A 0.45 carbon steel axle was reduced 1½ inch in diameter by a single cut, with a 9/64-inch feed per revolution, and a surface speed of 63 feet per minute. The lathe is unusually massive, as the accompanying illustrations show, so that it will withstand continued service of the most severe nature.

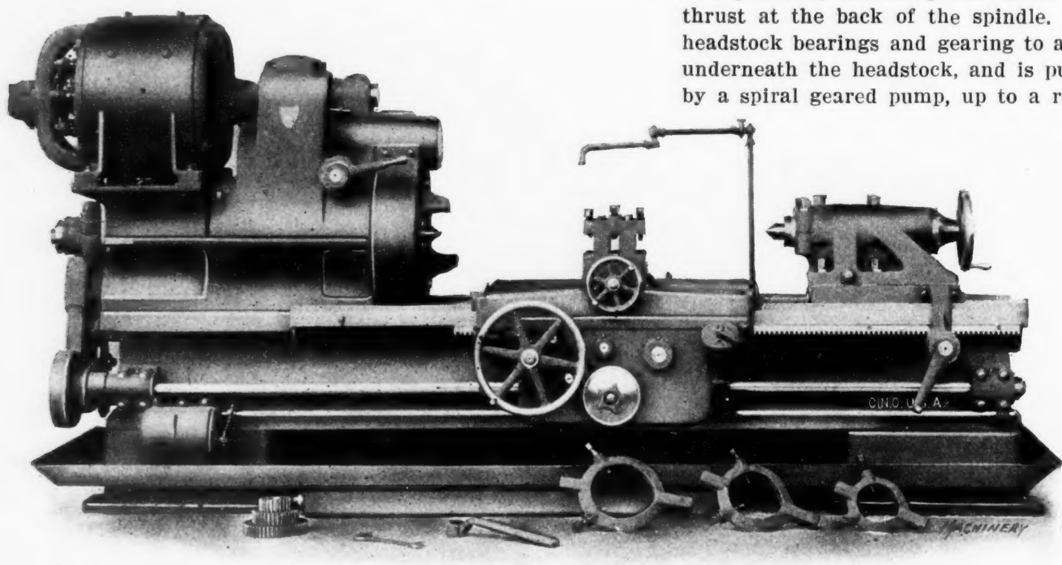


Fig. 1. Powerful Motor driven Lathe built by Lodge & Shipley

The actual swing over the carriage is 15 inches, and the swing over the bed 30½ inches. The arrangement of spindle speeds is such that the lathe is adapted only for turning work between centers; that is, the speed range suits only diameters which will swing over the carriage. The spindle speeds provide for turning at a rate not to exceed 140 feet per minute on 3-inch diameters, and not less than 61 feet per minute on 15-inch diameters.

The headstock is designed to receive a 30-horsepower direct-current, variable-speed motor, having a speed range of from 400 to 1200, but any type of motor can be applied and of any horsepower up to 40. There are two gear ratios, which, with the motor range of 3 to 1, give spindle speeds varying from 15.6 to 173 revolutions per minute. Any ratio of gearing may be provided to accommodate motors of higher speeds or to give the driving spindle any desired slower speed. The reducing of the spindle speed will, of course, increase the gear ratio. The driving gears within the headstock are of steel, and are hardened and heat treated. The lightest driving gear is 4 diametral pitch. The front spindle bearing is of large diameter and gives a projected area of 60 square inches.

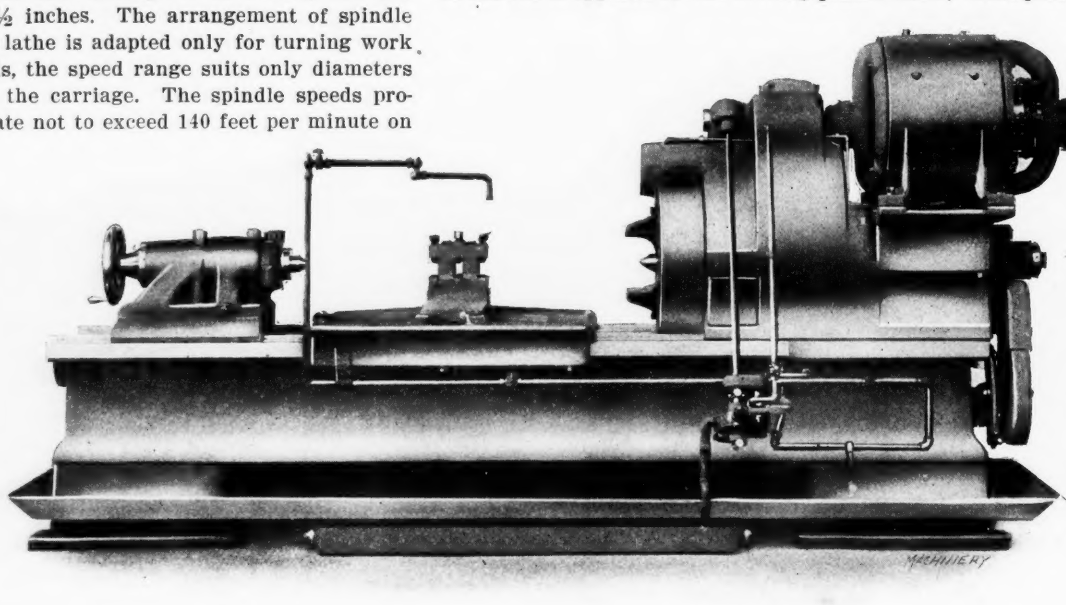


Fig. 2. Rear View of Forge Lathe showing Separate Pumps for Oiling Headstock and Supplying Lubricant to Cutting Tool

The spindle bearings are of standard composition metal. All other headstock journals are bronze bushed. The back spindle bearing is also of large diameter and gives a projected area of 47 square inches. The machine is provided with a compensating faceplate drive. The faceplate is 22 inches in diameter and is made of steel, as are the dogs which act as drivers. These drivers can be adjusted radially on the faceplate to accommodate driving dogs of various capacities and lengths. The driving shafts within the headstock are supported on both sides of the gears, thus eliminating all overhang.

Forced lubrication is provided for all of the driving gears and journals, including the main spindle bearing and the thrust at the back of the spindle. The oil drains from the headstock bearings and gearing to a reservoir cast in the bed underneath the headstock, and is pumped from this reservoir by a spiral geared pump, up to a reservoir at the top of the head, from which it is piped to the various bearings and gears. The spindle is solid, and runs against a solid, hardened steel plug at its back end, to oppose the tremendous thrust.

The centers are No. 6 Morse taper, and the one in the headstock is fitted into a hardened steel bushing forced into the spindle. The headstock is 48 inches long overall, and has covers which entirely enclose all the driving gears. The machine will deliver, with a 30 horsepower motor, about 19,500 pounds pull on an 8-inch shaft, and with a 30 per cent overload of motor, about 25,000 pounds. This would ordinarily create a pressure of 400 pounds per square inch on the spindle bearing, but the driving pinion is so placed that the pressure of the cut is opposed by the driving pinion itself; consequently this amount of pressure per square inch is greatly reduced.

The tailstock arbor is of large diameter and length, and is reamed for No. 6 Morse taper. It is made of tool steel. The tailstock has a long bearing on the bed, and a locking pawl engages a rack cast inside the bed.

The smallest gear in the apron is 3½ inches in diameter, and the finest pitch used, 5 diametral pitch. The smallest face of any gear in the apron is 1½ inch wide. All apron gears are of steel, and all bearings are bronze bushed. The friction

for locking the feed is placed on the outside of the apron to insure close inspection of friction faces at all times. The apron is double webbed, giving support at both ends of all studs. A rear view of the apron is shown in Fig. 3. The handwheel is 18 inches in diameter, and is geared so that one turn moves the carriage about 7/8 inch.

The carriage is very long, and the entire length bears on the bed. The total area of bearing surfaces on the bed is 245 square inches. It is gibbed both front and rear, and also under the inside V's. The bridge is extremely wide and strong, the tool-block is steel, and rests on a cast-iron cross-slide. It has one center slot to accommodate tools 1 1/4 inch by 2 1/2 inches, and two open sides for tools of the same dimensions. Serrated and hardened tool-steel plates are secured to the tool-block to give the tool a long bearing. The cross-slide is very long, and has 168 square inches of bearing surface on the top of the carriage. The cross-feed screw is of large diameter, and is placed as high as possible to resist the action of the cut. There is an oil trough cast entirely around the carriage, and this trough is placed below the inverted dovetail so that the lubricant from the cutting tool will not flood around the sliding surfaces. The carriage drains at the four low corners, back into the drip pan under the bed.

A separate and very substantial pump is provided for the cutting compound, which is geared positively from the headstock, and this pump will deliver a 3/4-inch stream of lubricant to the cutting tool at the rate of 16 gallons per minute. Instead of the usual flexible tubing there is telescopic tubing, (see Fig. 2) with proper stuffing boxes to take care of the longitudinal traverse of the carriage.

The bed is very wide at the top and unusually deep. It is mounted on cabinet legs, and has a heavy steel oil pan the entire length. This oil pan does not rest upon the floor, but is high enough to permit a cast-iron drip pan, mounted upon rollers, to be run under it. The lubricant from the chip pan is drained directly into the cast-iron pan and is pumped from this again to the cutting tool. This method separates the chips from the lubricant, and the chip pan itself is always comparatively dry.

The feed rod is of large diameter, and has two keyseats diametrically opposite for driving a steel bevel gear in the apron. The rod is driven by plain change gears, and four changes of feed are provided as follows: 1/16, 3/32, 9/64 and 3/16 inch per revolution. The feed gears are steel, of wide face, and coarse pitch. The motor controller rod extends along the front of the bed, and is operated by a handle near the top of the carriage.

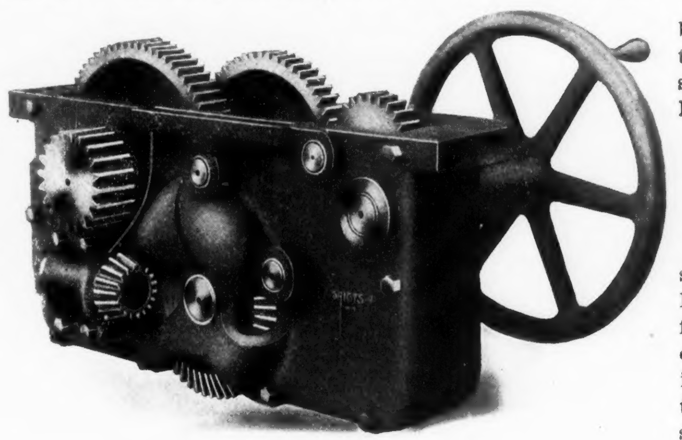


Fig. 3. Rear View of Forge Lathe Apron

BICKNELL-THOMAS CLUTCH

The Bicknell-Thomas Co., of Greenfield, Mass., is now manufacturing a roller grip clutch which contains few parts and is self-adjusting for wear and varying load conditions. It requires a small amount of space and is easily engaged. The construction of the clutch is shown in Figs. 1 and 2. Inside of the body *A*, which is free to rotate upon the shaft, there is a hardened steel bushing *B*, which is keyed to the shaft. A hardened steel cam-ring, which may be seen to the right in Fig. 1, is loosely mounted on the end of the clutch body. Fitting into slots in the body *A* and interposed between the cam-ring and bushing *B*, are three hardened steel rolls *D*. One end of a flat coil spring *E* is attached to body *A* and the other end to the cam-ring, which is held onto the body by a screw and roll *F*. On the inside of the cam ring and directly over the rolls, there are cam surfaces. The clutch is operated by shifting slide *G* which causes the coil spring *E* to slightly rotate the cam-ring upon the clutch body. As the result of this rotary movement, rolls *D* become wedged between the fixed bushing *B* and the cam-ring, thus causing the clutch and shaft to rotate as a single unit. A single clutch is composed of only sixteen parts, including the oil cup, shifter, thimble and collar, and all parts are interchangeable.

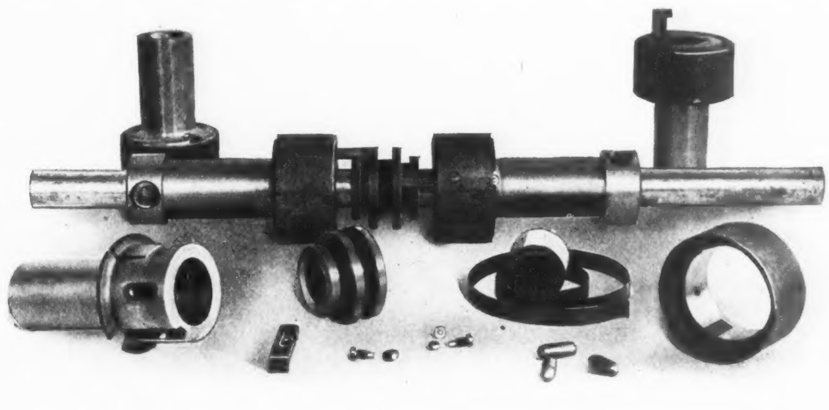


Fig. 1. View showing Single and Double Bicknell-Thomas Clutch and Component Parts

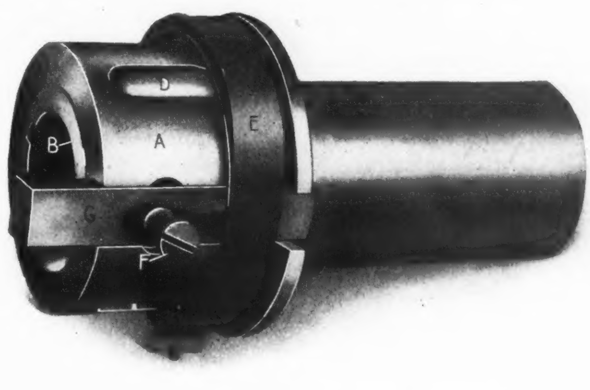


Fig. 2. Single Clutch with Cam-ring Removed

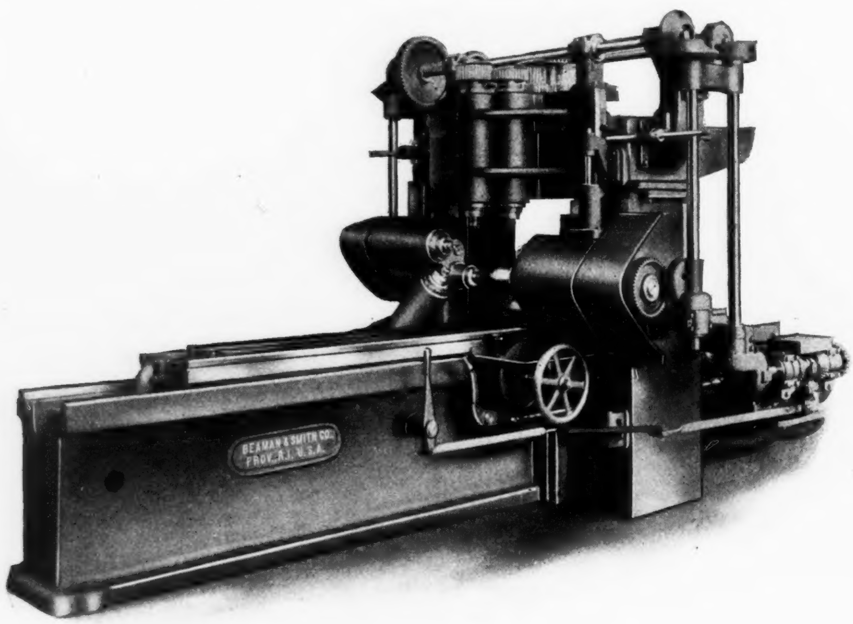
BEAMAN & SMITH NINE-SPINDLE MILLING MACHINE

The nine-spindle milling machine illustrated herewith is a special design recently built by the Beaman & Smith Co., Providence, R. I., for automobile manufacturers. This machine finishes, in one operation, three sides of as many "T-head" cylinder castings as the table will accommodate, thus greatly increasing the rate of production and giving a uniformity to the work that is impossible when each casting is machined separately.

The construction of the machine is similar, in many respects, to the regular planer or horizontal type, except for the arrangement and number of cutter spindles and the necessary changes in the driving mechanism. A saddle on each upright carries three spindles, five of which are in a horizontal position parallel with the platen, whereas one is at an angle of 45 degrees with the platen, as the illustration shows. In addition, three vertical spindles are carried by the saddle on the cross-rail. The saddles on the uprights have vertical movements and the one on the cross-rail, a horizontal movement.

The work-table has a maximum traverse of 10 feet, 10

inches on the bed, and it is 17 inches wide and 10 feet long. It has quick power movements in either direction, varying from 3½ to 14½ feet per minute. The table is operated by a screw which engages a revolving bronze nut, and the thrust is taken by ball bearings. An automatic stop is provided, and the feeds are so arranged that the desired rate can be secured for any spindle speed. The feed movements are positive in either direction, being transmitted through gearing contained in a conveniently located feed box. Nine changes are available, varying from 1 to 6 inches. The spindles are of crucible steel and run in hard bronze boxes. The 45-degree spindle has a 2-inch endwise adjustment and the others have a 1½-inch adjustment. The ends of the spindles are made to fit cutters according to specifications. The spindles all operate in unison and the speeds vary from 17 to 69 R.P.M. The front bearings are 3 inches in diameter, 4 inches long, and means are provided to compensate for wear. The rear bearings are 2½ inches in diameter and 4½ inches long.

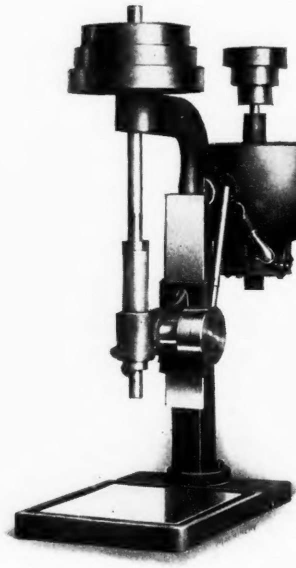


Special Beaman & Smith Nine-spindle Milling Machine

This machine is driven by a 7½-horsepower motor through gearing having a ratio of 23 to 1. The distance between the uprights is 31 inches and the maximum and minimum distances between the ends of the horizontal spindles are 15 3/8 inches and 5 7/16 inches, respectively. The minimum distance from the top of the table to the ends of the vertical spindles is 18 1/16 inches and the maximum, 19 9/16 inches. The distances between the centers of the spindles in each saddle are fixed, the positions of the spindles being governed to suit requirements. The weight of the entire machine is approximately 20,000 pounds. All fast-running shafts have bronze-lined boxes; the bearings are finished by grinding; the sliding surfaces are scraped, and all the gears, many of which are of steel, are cut from the solid.

WILLEY 12-INCH SENSITIVE DRILL

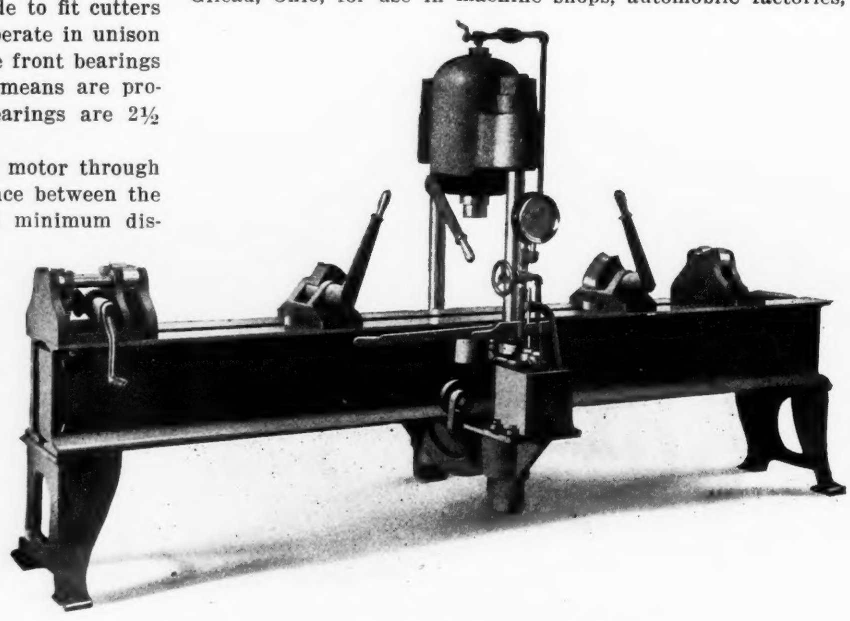
The Willey Machine Co., Jeffersonville, Ind., has brought out a new design of 12-inch sensitive drill. This machine is of the bench type and is driven by a motor which connects with the spindle by a belt operating on the three-step cone pulleys shown. Three changes of speed are available. The motor is adjustably mounted for varying the belt tension. The starting switch is within the motor frame. The motor can easily be detached and exchanged for another, in case it is necessary to use a different voltage or an alternating current. The motor is mounted high enough on the column to be out of the way of dirt and chips. The sliding head has a movement of 8 inches on the column, and the machine drills to the center of a 12-inch circle. The greatest distance from the spindle to the table is 11 inches, and the traverse of the spindle is 3 inches. The total height of the machine is 26 inches, and its weight, 90 pounds. The maximum power of the motor is ¼ horsepower.



Twelve-inch Motor-driven Bench Drill

HYDRAULIC BAR STRAIGHTENER

An improved hydraulic bar straightener has been designed by the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, for use in machine shops, automobile factories, garages, etc. This machine will quickly bend or straighten bars, shafts or axles and it is adapted to various sizes of stock. The construction is simple and a powerful pressure can easily be exerted on a bar or axle.



Hydraulic Bar-straightener built by the Hydraulic Press Mfg. Co.

The press frame is formed of two steel I-beams having rigid stands at the ends, and the press itself is mounted on a carriage which rolls along the lower, outer flanges of the I-beams. A bracket on the carriage supports the pump and water-box, as the illustration shows. The cylinder strain rods are extra strong and have a large factor of safety. A pressure gage and safety valve are provided to eliminate all danger from overstrain. The upper surface of the I-beams is machined, thus

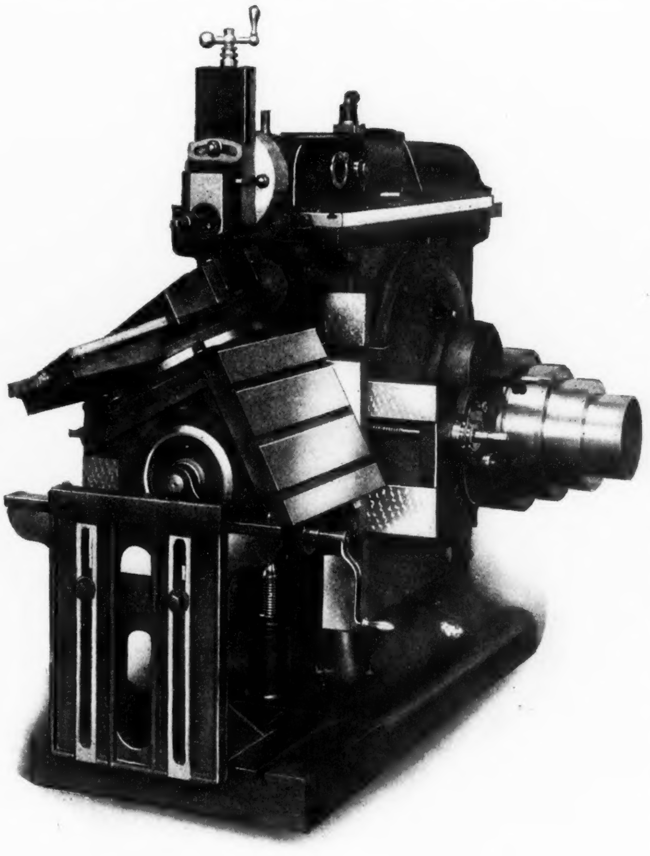
providing a true surface upon which the bending blocks and the tail roller center can slide. By means of the roller centers, axles or shafts can easily be turned to the required position by the hand crank shown. The press can be rolled to either end of the frame with one hand, thus permitting the work to be placed in position without pushing it in endwise.

When the press is in use, the axle or shaft to be bent is placed on the roller centers and turned to the required position. The levers of the bending blocks are then thrown back, thus lifting the axle from the roller centers. The ram is next lowered to the proper position by a hand-lever attached to it, which operates through a rack-and-pinion movement. Everything is now ready for applying the pressure. The pump is operated by hand, and as it is provided with a 30-inch extension handle, pressures up to 125 tons are easily obtained. A pressure of 75 tons is sufficient to bend a solid iron bar 4½ inches in diameter, with the supports 30 inches apart, whereas a pressure of 125 tons will bend a bar 6 inches in diameter with the supports 36 inches apart. It is evident, of course, that larger bars can be bent by increasing the distance between the supports. The ram has a movement of 4 inches, but by using extension blocks which can be attached to it by a set-screw, the advantage of a longer travel can be secured. This makes it possible to straighten large or small bars.

This type of straightener is made in various sizes, having a beam length of from 9 to 25 feet, and with pressure capacities varying from 75 to 125 tons. In addition to the roller centers, the machine may also be equipped with spring centers, both forms being interchangeable.

STOCKBRIDGE SHAPER WITH SUPPORT FOR SWIVELING KNEE

The Stockbridge Machine Co., Worcester, Mass., is now equipping shapers of the swiveling knee type with an outboard support. This support is similar to the type used previously on the shapers built by this company having a standard stationary



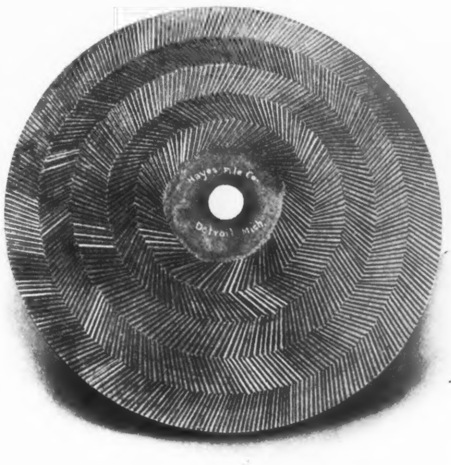
Stockbridge Shaper with Swiveling Knee and Outboard Support

knee, and it is designed to hold the table rigidly in any position. The knee is revolved by means of a worm and gear operated by a handle conveniently located on the working side, as shown in the illustration. A dial on the front of the knee, which is graduated in degrees, permits setting the table to any angle when planing bevels. One side of the knee can also be equipped with a tilting top, thus making it possible to plane compound angles.

This swiveling knee support is now applied to the 16-, 20- and 24-inch back-geared shapers, and the 18-inch all-geared type. The machine illustrated is a 24-inch size. The necessity for supporting a knee of the swiveling type is just as great as, if not greater than, for a stationary knee, as shapers having the former design are frequently used for planing parts requiring considerable accuracy.

HAYES CIRCULAR FILE

The circular file shown herewith is intended for filing aluminum, solder, babbitt, and other soft metals. The particular file illustrated is 14 inches in diameter and 1 inch thick. There are teeth on both sides of the file and these are cut by hand. When the file is in use, it is mounted on a stand like an emery-wheel and is rotated at a speed of 200 revolutions per minute.



Circular or Rotary File for Filing Soft Materials

The Ford Motor Car Co. uses a file of this type for filing connecting-rod caps, the babbitt on these caps being "surfaced" by simply holding them against the side of the revolving file. This file is manufactured by the Hayes File Co., Detroit, Mich. It can be obtained in any diameter desired, and either the thickness or grade of cut is varied to meet individual requirements. The file does not clog, and it is especially valuable for finishing soft metals such as those mentioned.

BLISS DOUBLE-DRAW PRESSES

Double-draw presses are the latest development for producing cupped articles or shells by the drawing process. They differ mechanically from the ordinary double-action press in having three, instead of two moving slides, and, therefore, might appropriately be called triple-action presses. The primary object sought in the double-draw press, is to save time and increase production by making two drawing operations on a single article with one stroke of the press, or to draw and re-draw, or re-draw twice in a single operation. It will be seen that this type is, therefore, particularly adapted for articles that require more than one drawing operation to bring them to required dimensions.

The economies effected by this method of drawing, are not due to the simplicity and rapidity of mechanical production alone, but also to reduced handling of shells and the smaller space occupied by the machinery and partially finished product. In addition, the annealing of shells between operations is unnecessary. With the double-draw press, annealing is avoided, as one drawing operation immediately succeeds another, and the heat generated in the first drawing remains in the shell. As annealing involves much expense in the maintenance of furnaces, handling and cleaning annealed shells, etc., the economy, in this respect, is important.

The double-draw presses illustrated herewith are two of a line of six sizes built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. The performance of these machines is said to be very satisfactory. The presses range in drawing capacity

for blanks up to 25 inches in diameter, and the material varies from 1X tin to steel 1/16 inch thick. Shells have been produced having depths up to 10 inches. The smaller sizes are of a somewhat different construction than the larger, being arranged for dies with cutting edges, in order to cut blanks, draw and re-draw in one stroke. The larger sizes (beyond a 12-inch diameter blank capacity) are not adapted for the use of dies with cutting edges.

The slide movements in these presses operate the dies as follows: A double die with the blank on its top, is brought in contact with a blankholder. A tubular punch then descends into the top section of the die, making the first draw. The tubular punch then stops and dwells, thus acting as a blankholder during the second draw. The second draw is performed by a punch that descends through the tubular punch into the lower section of the die, the second draw beginning immediately after the first is completed.

Fig. 1 shows a machine used for cutting blanks up to 12 inches in diameter, from brass sheets or strips up to No. 22

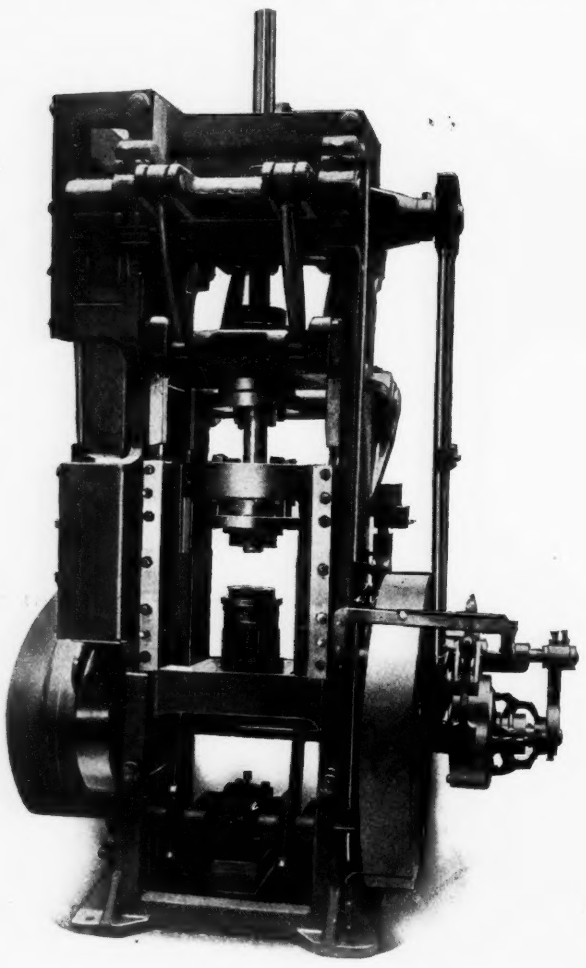


Fig. 1. Double-action Press arranged for Cutting and Drawing

gage thickness, and performing two drawing operations on them. In this machine, the die bed is fixed and rigid and the blankholder carrying the top cutting edges, moves in long adjustable guides. The moving parts are mechanically balanced, as far as possible, and are started and stopped by means of a combined, toggle friction-clutch and brake, either automatically or by hand. The blankholder is actuated by toggles that receive their motion from a cam. These toggles produce a perfect blankholder dwell during the drawing period and receive the blankholder pressure, thus relieving the cam of pressure during that time. The first draw punch slide is actuated by a crank and toggle motion, and the second draw punch by a simple crank motion.

Fig. 2 shows a machine that takes blanks up to 21 inches in diameter and of steel to No. 20 gage thickness. It will receive first draw punches up to 14 inches in diameter and produce shells up to 8 inches final depth. In this machine, the lower dies are fastened to a table that has motion and are brought up against a stationary adjustable blankholder. The table is moved up and down by toggles actuated by a large cam groove in the main gear. The toggles take all the pressure due to the blankholder and the descent of the punches, so that the cam only moves the table up and down. As the table is counterbalanced, its work is very light, which eliminates wear.

The first draw punch slide receives its motion through tog-

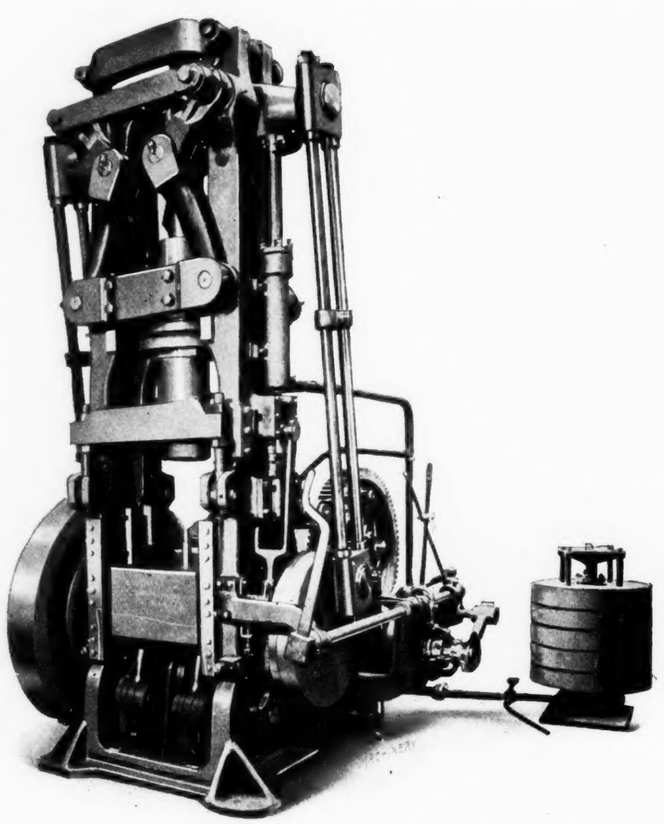


Fig. 2. Double-action Press for Blanks up to 21 Inches in Diameter

gles from the second draw punch slide. These toggles provide a fine dwell for the first draw punch, during the drawing period of the second punch. All the moving parts mentioned, are counterbalanced during their up and down movements by a hydraulic plunger and accumulator system, which makes the starting of the press easy, certain and safe. The hydraulic

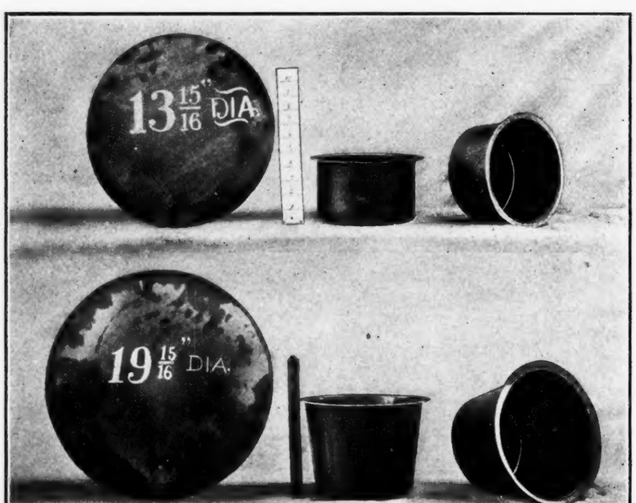


Fig. 3. Blanks and Shells produced from Flat Blank in one Operation on Bliss Double-draw Press

accumulator can be placed in the most convenient position, either below or above the floor line. The machine is driven and controlled by means of a powerful combined, friction clutch and brake fitted with both hand and automatic control. Larger machines have hand control only. Convenient adjustments are provided for the first and second draw punches and stationary blankholder.

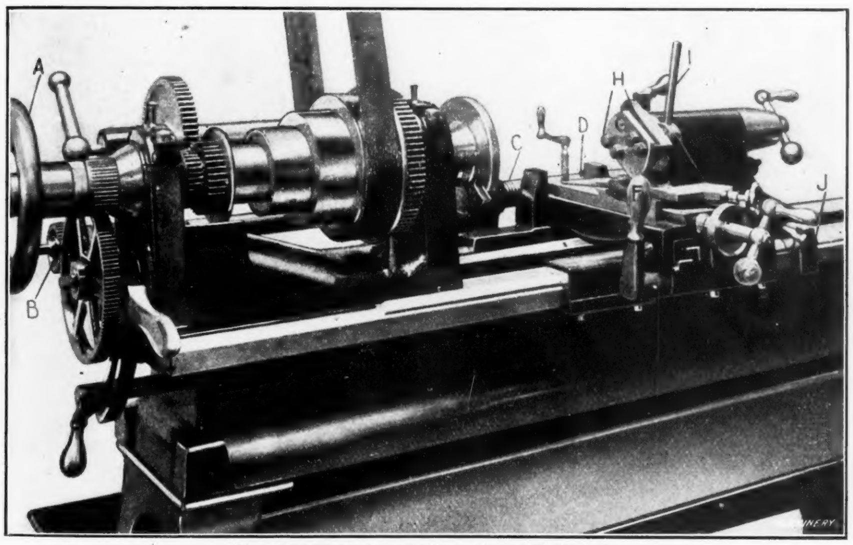
These machines embody many improvements in detail, resulting from a long experience with drawing presses of this type.

BICKFORD SPECIAL THREADING LATHE

The Bickford Machine Co., Greenfield, Mass., is now building a threading lathe designed with special reference to the needs of tap makers. The general construction of this lathe is similar to an ordinary engine lathe, there being a regular back-geared headstock and a divided tailstock having a lateral adjustment for taper work. The bed has short legs and is mounted in an oil tank base. The spindle is hollow and is provided with a draw-in collet attachment operated by handwheel *A*. The capacity of the largest collet is 1 inch. The lathe swings 13 inches over the ways, 4 inches over the compound carriage, and takes 28 inches between the centers. This lathe is so designed that threads can be cut in a comparatively short time.

The lead-screw *C* is mounted in a bracket at the rear of the bed and it can be adjusted to any position. Motion is transmitted to this lead-screw through change gears and a telescoping shaft, and it is driven at the ratio of 1 to 1; 1 to 2; 1 to 3 or 1 to 4. With these ratios, a 4-pitch lead-screw can be used to cut a 4, 8, 12 or 16 pitch thread. The change gear on the lead-screw is shown at *B*. The carriage is so divided that the upper part slides across the lathe and carries a half-nut *D* which can be meshed with the lead-screw. This part of the carriage is operated by raising lever *F*, which not only engages the nut with the lead-screw, but is used as a handle for returning the carriage to the starting point. This lever moves to a "dead center" position, so that the cutting tool does not tend to crowd away from the work. The lead-screw thread is of the buttress form, and there is a simple clutch dog at one end, so that the screw can easily be replaced with another of different pitch. The half-nut is also easily detached.

The roughing and finishing thread chasers *H* are of the Landis or milled type. These are held by holder *G* which, in turn, is supported on a compound slide. The chasers are fed in nearly to the required depth by this slide so that the benefit of an angular shear cut is obtained. The chasers are clamped to the holder by lever *I*. The maximum length of thread that can be cut at one setting is 10 inches, but the convenient adjustment afforded by the compound rest for aligning the chasers, makes it feasible to cut a length of 10 inches and then slide the lead-screw along for threading another section. A positive stop *J* is provided for the carriage.

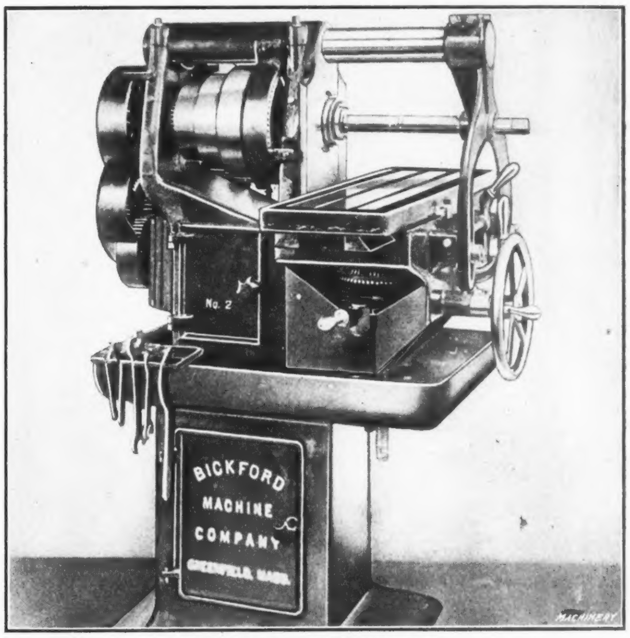


Bickford Threading Lathe of Special Design

BICKFORD PLAIN MILLING MACHINE

The milling machine shown in the accompanying view is built for plain manufacturing operations, in connection with which a rigid design is more desirable than one possessing a wide range. The knee and saddle are formed of one solid casting, which gives the table a rigid support. The table has a bearing 24 inches long and 8 inches wide. The feed is of a rack-and-pinion type. By means of a special clutch and gear device inside the knee, a handwheel at the side of the machine can be connected to operate the knee up or down, or the table in either direction. This change is made by simply moving a lever at the front of the table, to the right or left.

The spindle is of crucible steel and runs in phosphor-bronze bearings. The front bearing has a taper hole in which the spindle is held from end motion by a special clamp collar. This bearing may be adjusted a distance of ¾ inch through the main housing to which it is splined and held by a nut at each end. The front end also has a graduated collar provided with a clamp screw for setting it back to zero from any position. The cone pulley runs free on the spindle and has a small gear which drives the back-shaft, and the latter drives the main gear on the spindle. The ratio of this gearing is 6 to 1. The pulley is held in position by a spring collar located between one end and the main driving gear which travels longitudinally with the spindle.



Bickford Plain Milling Machine

The feed motion is transmitted through a coarse pitch worm in mesh with a large gear on the pinion shaft. The end pressure of this worm is taken by a ball thrust bearing. The feed shaft is all gear driven. The feed changes are effected by opening the door in front of the machine and shifting a lever. The gear box gives ten feed changes for each of the three spindle speeds or a total of thirty changes in all.

The overhanging arm is of steel and 3¼ inches in diameter. The drop arm and braces are cast integral. The levers operating the power feed and stop are conveniently placed. The table has a deep oil channel extending around the platen and loose "splashes" (not shown) are provided for carrying the overflow of oil to a tank in the base. The lubricant is forced to the tool by a gear pump at the rear of the machine. The working surface of the table measures 7¼ by 29½ inches. The weight of the machine is 1750 pounds, and this same type is built in larger or smaller sizes. It is built by the Bickford Machine Co., Greenfield, Mass.

CHAMBERSBURG STEAM-HYDRAULIC PRESSES

The Chambersburg Engineering Co., Chambersburg, Pa., has developed a line of steam-hydraulic forging presses which are built in both the single-frame and four-column types. The single-frame presses range in size up to and including 400 tons pressure, and the four-column types up to and including 5000 tons capacity. These presses have a double-lever control, and multiple tonnages for the larger sizes. With the double-lever control, the entire operation of the press is governed by

the two hand levers seen in Fig. 1 of the accompanying illustrations. As these levers perform the same functions as the two levers on a steam hammer, the operation of the press

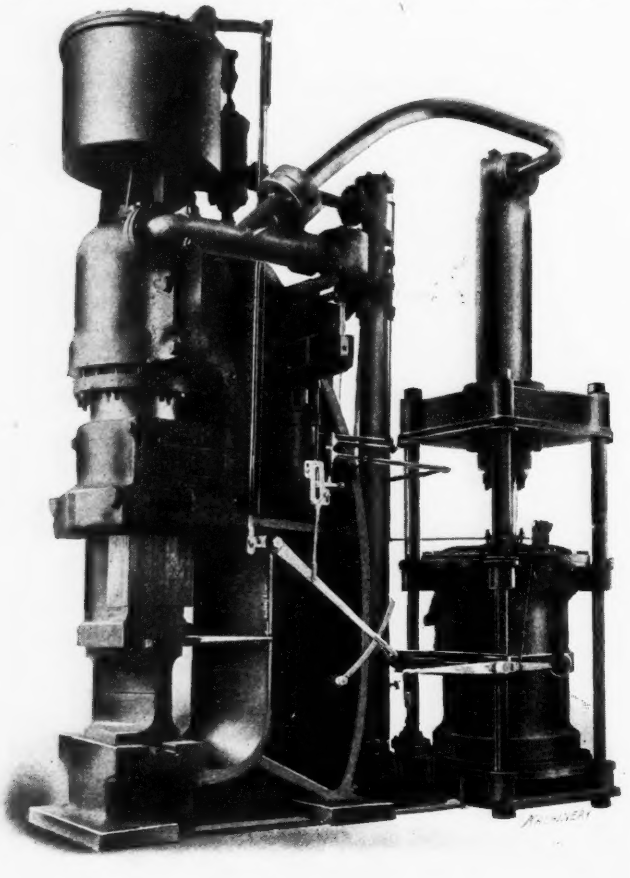


Fig. 1. Chambersburg Steam-hydraulic Press with Triple Intensifier

comes naturally to the workman. With one lever, the position of ram is adjusted for the length of stroke, and with the throttle lever, the power of the stroke is varied. In both cases the ram follows the direction in which the lever is moved.

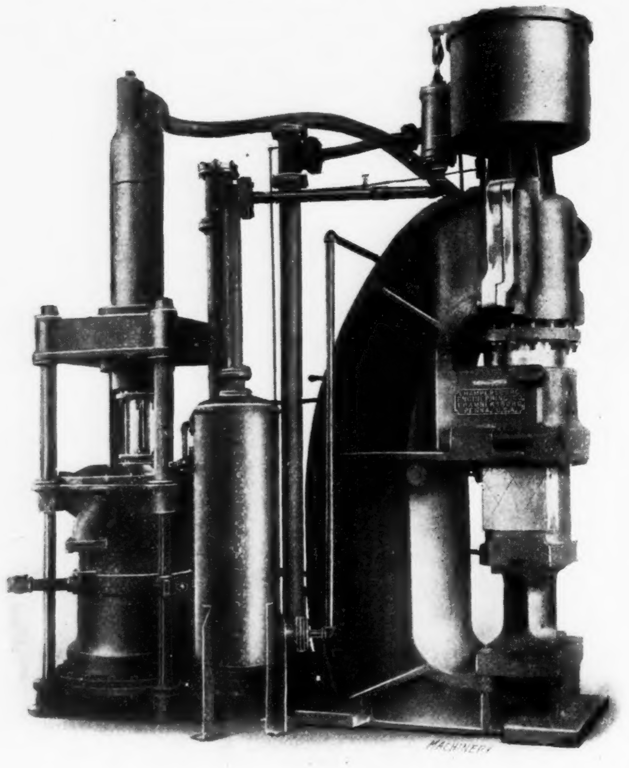


Fig. 2. Opposite Side of Steam-hydraulic Forging Press

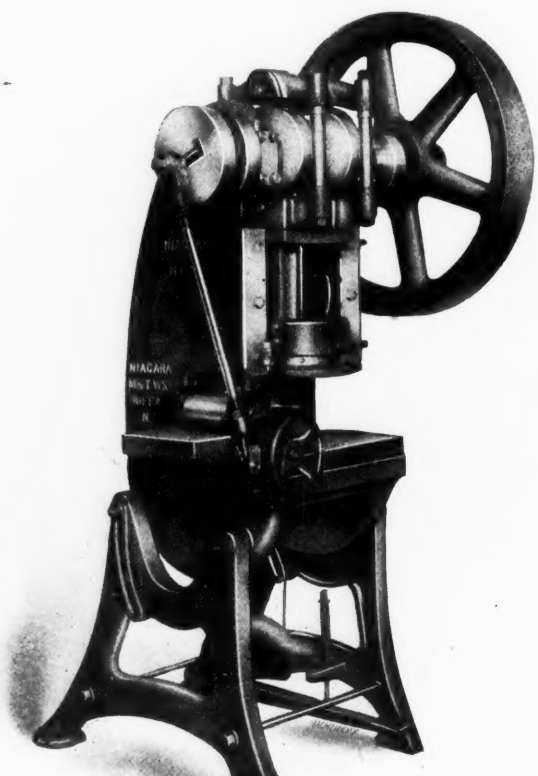
For the larger size presses, great economy in steam consumption is said to be effected by means of a triple intensifier which enables the operator to use selective pressures in proportion to the varying necessities of the work; in other words, the amount of steam used is regulated in accordance with the requirements of the work being forged. The usual practice has been to use a single-cylinder intensifier which consumes a constant volume of steam, whether the press is exerting a 500-ton pressure, or 2000 tons in a press having a maximum capacity of 2000 tons. In the Chambersburg design, a press having a maximum capacity of 2000 tons is arranged for three multiple pressures of 600 tons, 1200 tons or 2000 tons, with the steam consumption proportional to the tonnage being used.

The main frame of the 400-ton single-column press illustrated, is an open-hearth steel casting of I-beam section, the web being stiffened by heavy ribs. Projecting flanges at the base form a support for the press. The frame has heavy guides for the ram, fitted with a cap which is held rigidly by bolts to take care of strains in any direction when forging beveled work. The dies are skewed so that the work will clear the frame when either drawing or finishing, and the notches in the ram and die seat can be planed to suit any existing dies.

NIAGARA DOUBLE-ACTION CAM PRESS

The Niagara Machine & Tool Works, Buffalo, N. Y., has added to its line of presses the double-action cam press, shown herewith. This machine is intended for cutting and drawing shells, and possesses several new and interesting features.

Instead of making the adjustment on the blankholder slide (to accommodate dies of various heights) by means of screws



Niagara No. 85 Cam Press

connected to the cam roller yokes, a threaded sleeve is used on the lower end of the blankholder slide, which enables the adjustment to be readily and accurately made. This arrangement also makes it possible to locate the guides for the blankholder slide, directly in line with the center of the crankshaft. Adjustable gibs are provided, not only for the blankholder slide, but also for the inner slide, which is a decided advantage when using combination cutting and drawing dies.

The design of the press, in other respects, conforms with the most improved practice on machines of this type. The outer slide or blankholder is positive in its motion and it is raised and lowered by two cams keyed to the main shaft on each side of the crank. The cam roller yokes are rigidly connected with the blankholder, and provision is made for taking up wear. The lower cam rollers are set in oil boxes to insure good lubrication for both rollers and cams. The inner slide

receives its motion from the crankshaft by means of a pitman, which has vertical adjustment. The press illustrated is equipped with a single roll feed attachment. Presses of this design are made in several sizes.

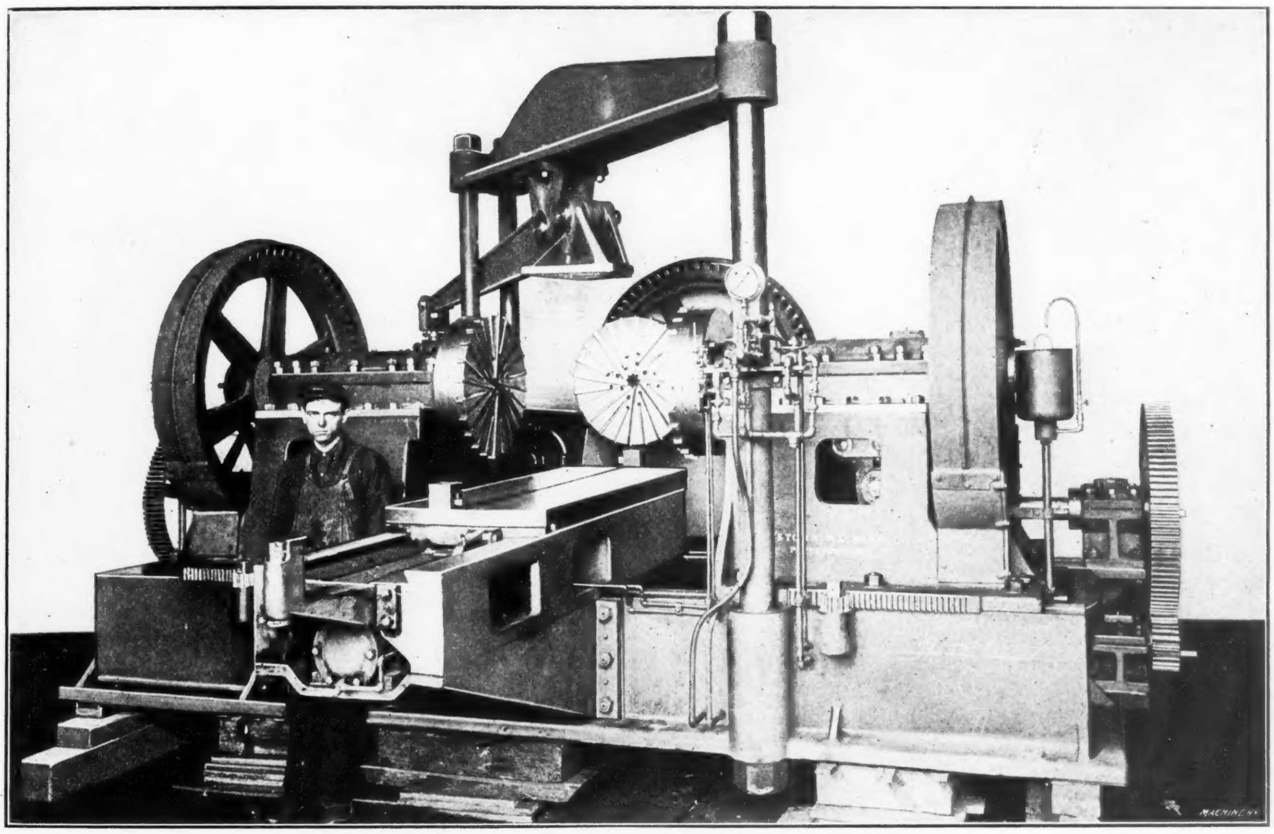
LARGE THREE-WAY FLANGE FACING MACHINE

The Pottstown Machine Co., Pottstown, Pa., has designed a very interesting machine for facing the flanges of large pipe fittings, valve bodies, and similar work. This machine is equipped with three 25-inch facing heads which operate simultaneously. The arrangement of the heads and method of driving them will be seen by referring to the accompanying illustration. The power is derived from a 35 horsepower motor at the rear, which drives through gearing having a ratio of 256 to 1. The spindles are carried by slides which are mounted in heads resting on the main bed. The spindles have a longitudinal movement of 1½ inch, which is sufficient to clear a rough casting and face the flanges to the finished dimensions. Each spindle is fed into the work by an air cylinder, and the feed is controlled by an oil cylinder. These cylinders are located inside the bed and connection is made with the spindle slides by levers which give a powerful feeding movement. The heads carrying the spindles can be adjusted along the bed to accommodate work of different widths. This adjustment is effected by racks and pinions located at the base, as shown in the illustration. Each head is rigidly secured to the bed by six 1½ inch bolts, and the back thrust is further provided for by jack-screws which rest against the ends of the bed and give a positive support.

The work is held in position by a massive steel yoke located above the machine and equipped with a lever and pneumatic cylinder, which is capable of exerting a pressure of fifty tons on the fitting. The movements of the work table, pneumatic clamp, and the facing heads, are controlled by three air valves, which are conveniently located on the yoke column at the right side of the table. An air gage is provided to show what pressure is being applied to the fitting, in order to prevent feeding the cutters against a casting before it is firmly clamped. The work table is long enough to permit using a double set of fitting holders or fixtures, so that the workman can load one fixture while the casting on the other end of the table is being faced.

The method of operating this machine is as follows: The fitting is placed in the fixture and the table is moved in by air to the working position. The three heads are then fed in to the required depth, and while this is taking place, the operator places another casting in the fixture attached to the outer end of the bed. When the inner casting is faced, the cutters are withdrawn and the table is moved outward to clear the heads, after which it is turned halfway around, thus bringing the rough casting in to the facing position. As all of these movements are pneumatically controlled, they are effected quickly by simply working the small air-valves shown. It should be mentioned that the distance which each head feeds inward is predetermined by a stop that arrests the movement of the feed lever and prevents further cutting.

Each facing head has twenty-two high-speed steel cutters which are mounted radially and operate across the entire surface of the flange. The cutter-head spindles are 8 inches in diameter, and the driving gears have a diameter of 51 inches and a face width of 7½ inches. The maximum distance between the front cutter-heads is 45 inches, or 22½ inches from the center of a fitting. The two front heads will face to a minimum width of 9½ inches. The height from the top of the table to the center of the spindle is 16½ inches. The total floor space required by the machine is 17 feet, 4 inches, by 16 feet, 5 inches. The over-all height is 8 feet from the floor line, which is about 8 inches below the top of the main bed. The weight of this machine is 60,000 pounds.



Special Flange Facing Machine built by the Pottstown Machine Co.

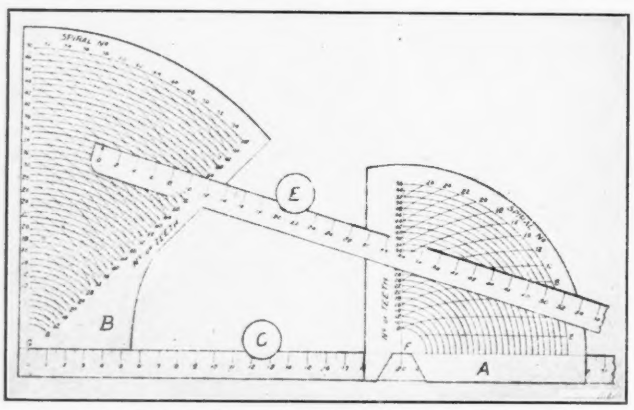
LINEOMETER FOR DETERMINING CHAIN LENGTHS

The Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., has developed an instrument by means of which the length of a sprocket or driving chain can be quickly determined without making a calculation. This instrument is known as a chain lineometer, and it enables the length to be ascertained by making three simple adjustments. The instrument in its simplest and cheapest form is made of paper (as shown in the accompanying illustration), and there is also a high-grade steel instrument, which operates on the same principle.

Referring to the illustration, there is a fixed scale *C* laid off in half-inch divisions, each representing a distance equal to the pitch of the chain. On the movable scale *E* each half-inch

division represents a distance equal to two pitches—one for the upper half of the chain and one for the lower half. The circles on the sectors *A* and *B* are the pitch circles or 1-inch pitch sprockets, drawn half size. These circles are crossed by spirals having numbers which represent the number of chain links from the point where each spiral crosses a given circle to the corresponding point on the lower half of the circle.

As an example for illustrating the use of this instrument, suppose it is desired to find the chain length for sprockets having 72 and 36 teeth, respectively, a center-to-center distance of 15 inches and a pitch of ¾ inch. If the center distance is divided by the pitch, the result is 20, which is the center distance *in terms of the pitch*, and the sector *A* is set at this figure on scale *C*. The straightedge *E* is next set approximately tangent to the two pitch circles at *A* and *B*, corresponding to 36 and 72 teeth, respectively. The point where the spirals cross these pitch circles is then noted and the straightedge is shifted so that it covers all but one of these points. The zero point on the scale is set to coincide with the point not covered on the left-hand dial, and the point not covered on the right-hand dial should just touch the straightedge. In other words, place the straightedge in the position that the center line of the chain would occupy in passing from one sprocket to the other. The straightedge reading at the intersection of the spiral and pitch circle lines on the right-hand sector, equals twice the number of links in the span of "free" chain. For example under consideration, this is 38, and the number marked on the spiral passing through the zero point is 44, whereas, the number of the spiral passing through the thirty-eighth division is 14. The sum of these three numbers (96) is the chain length *in terms of the pitch* and 96 × ¾ inch = 72 inches, which is the length in inches.



Instrument made by Diamond Chain & Mfg. Co. for Determining Chain Lengths

As the length of a roller chain must, in general, be a multiple of twice the pitch, the reading on straightedge *E* must be an even number. If the spiral does not pass exactly through one of the even-numbered scale divisions, the next higher even number is used. If an offset connecting link is employed, this number must be odd, and if the chain is of the "block" type, the reading may be either even or odd, since the chain length can be any multiple of the pitch. With the steel instrument previously referred to, the adjustments are greatly facilitated. The right-hand sector is quickly clamped into position by a thumb-screw, and the zero point of the straightedge is brought to the proper pitch circle by a slide which is graduated on the left for roller chains and on the right for block and twin-roller chains. There is also a linked connection which allows the straightedge to swing about its zero point.

If it is desired to determine a center distance which will eliminate slack in the chain, shift the right-hand sector until one of the regular divisions of the straightedge is on a spiral; then take the center distance reading and multiply by the pitch. To find the length of a belt, a special set of sectors must be used.

CINCINNATI EIGHT-INCH PRECISION BENCH LATHE

The Cincinnati Precision Lathe Co., Cincinnati, Ohio, has brought out a new precision bench lathe which is a decided departure from conventional designs. This lathe is a friction-driven type and has a single constant-speed belt pulley. This arrangement does away with a cone pulley on the spindle, thereby permitting the use of exceptionally long bearings; in fact, the spindle has a bearing that is practically continuous (as will be seen by referring to Fig. 1) which gives a very rigid support and obviates chattering.

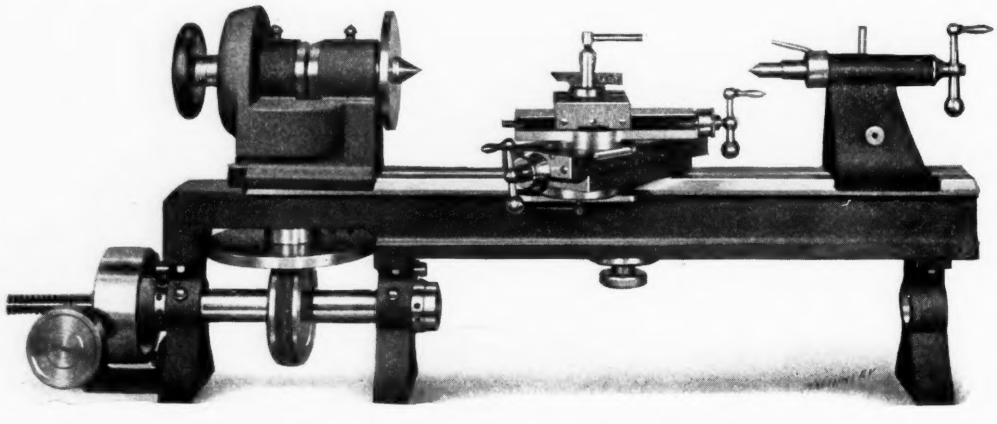


Fig. 1. Precision Bench Lathe built by the Cincinnati Precision Lathe Co.

The method of transmitting power from the main belt pulley to the spindle is shown more clearly in Figs. 2 and 3. The main driving pulley is keyed to a hollow, slotted driving shaft which contains a rack shaft, by means of which the position of the driving friction disk is varied, as will be explained later. A key passes through both of these shafts and engages the driving friction disk which transmits the movement to the horizontal driven disk above it. The latter is keyed to a vertical spindle which drives the lathe spindle through a pair of accurately cut miter gears, as shown in Fig. 2. There is a ball thrust collar bearing between the horizontal friction disk and the lathe bed, and the miter gears run in oil.

The mechanism for varying the speed adjustment is shown in the sectional view, Fig. 3. The rack shaft, previously referred to, meshes with a pinion attached to a handwheel on the outer edge of which is a speed indicator. By means of this handwheel, the friction driving wheel is shifted on the driven disk for obtaining any desired speed in either a forward or reverse direction. When the position of the disk is changed, the driving key slides in a slot cut in the hollow shaft. There is a depression in the center of the driven disk, so that the machine can be stopped independently of the

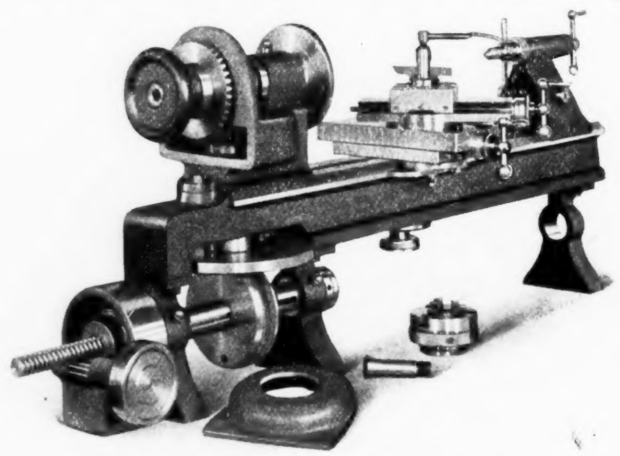


Fig. 2. Another View of the Precision Lathe—Spindle Gear Guard removed

driving belt. If desired, the friction disk can be chamfered at the outer edge to permit stopping the machine by placing the driver either at the central or outer positions. This friction transmission is said to give a strong drive, thus making it possible to take heavy cuts as well as light delicate cuts. The face or periphery of the driving friction disk contains layers of specially treated oak-tanned leather, subjected to a high pressure in order to increase its durability.

Any wear which may occur between the friction disks, can be taken up by means of eccentric bushings so arranged that the friction driving shaft may be raised or lowered parallel to the face of the driven disk. The power required for the heaviest cuts taken on a precision lathe, is so small in proportion to the efficiency of the drive that the friction mechanism cannot be overloaded.

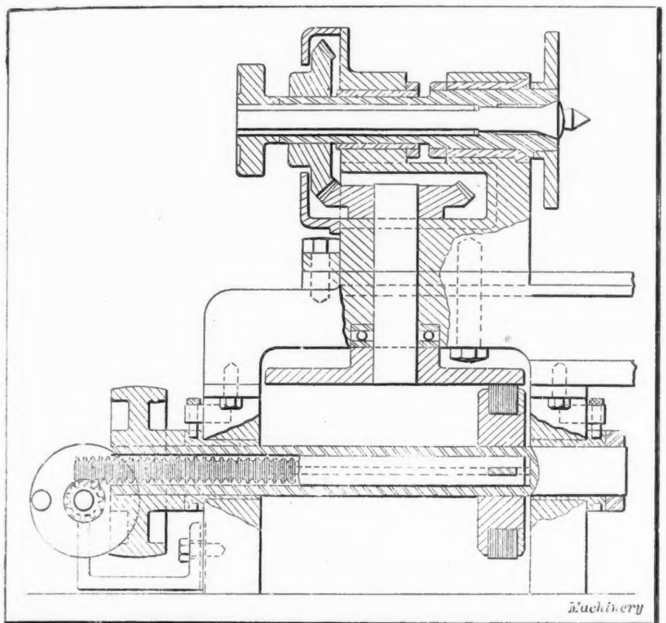
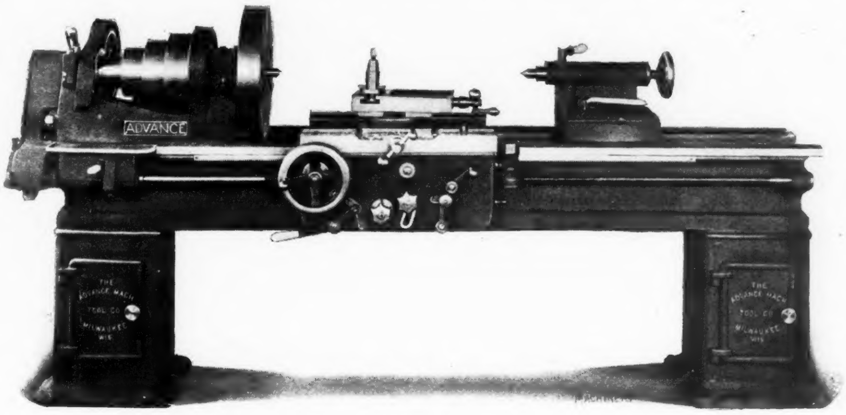


Fig. 3. Sectional View showing Arrangement of Driving and Speed Adjusting Mechanism

The location of the belt pulley eliminates overhead countershafts and permits driving from beneath the bench if desired. When the power is applied from beneath the bench, clutch friction pulleys are used, thus doing away with the tight and loose pulleys. This machine is constructed throughout of high-grade materials. The castings are of "close" iron and they are properly seasoned after being roughed out, before finishing. The spindle is hardened, ground and lapped and its bearings are of high-grade phosphor-bronze. The swivel slide rest is designed along modern lines and is built to withstand heavy service, if necessary. This lathe was designed by Mr. J. M. Tatman of Cincinnati.

ADVANCE NO. 2 ENGINE LATHE

The Advance Machine Tool Co., 591 Twenty-second St., Milwaukee, Wis., has brought out a heavy-duty engine lathe which embodies a number of improvements. The feed mechanism is located in the apron (see accompanying illustration), where it is always within convenient reach of the operator, regardless of the position of the carriage along the bed. This mechanism gives four feed changes varying from 0.015 inch to 0.060 inch. A wide range of feeds can also be obtained through change gears operated by a lever at the headstock end of the lathe.



Lathe built by Advance Machine Tool Co.

This machine has a swing over the V's of 18½ inches, and a swing over the carriage of 12 inches. The tailstock is of the offset type, thus permitting the compound rest to be set parallel to the centers when close to the tailstock. The headstock is extra heavy and has large bearings for the spindle. The spindle is made of chrome-nickel steel and has a 1 9/16-inch hole extending through it. The apron is the double-plate pattern and has no loose brackets of any kind. There is only one friction clutch for both the lateral and cross feeds, thus making it impossible to engage more than one feed at the same time. The lead-screw nut is provided with a stop so that the feeds cannot be operated while chasing threads, and *vice versa*. This lathe is of the heavy pattern, and is tested for alignment within a limit of from 0.001 to 0.0015 inch.

AMES UPRIGHT DIAL GAGE

The upright gage illustrated herewith is an addition to the line of dial gages manufactured by B. C. Ames Co., Waltham, Mass. It is of a low, compact design which is not easily upset and can be placed in the most convenient position for the operator. This gage is desirable for measuring paper, flexible cardboards, fabrics, and rubber, as well as metals of all kinds which have flat surfaces. It can be arranged with a small surface in place of the platen, for measuring sheet metals or any other material which does not have a flat even surface. The spindle of the gage has a travel of 3/10 inch, the same as the regular upright gage made by this company.

Dial Gage made by B. C. Ames Co.

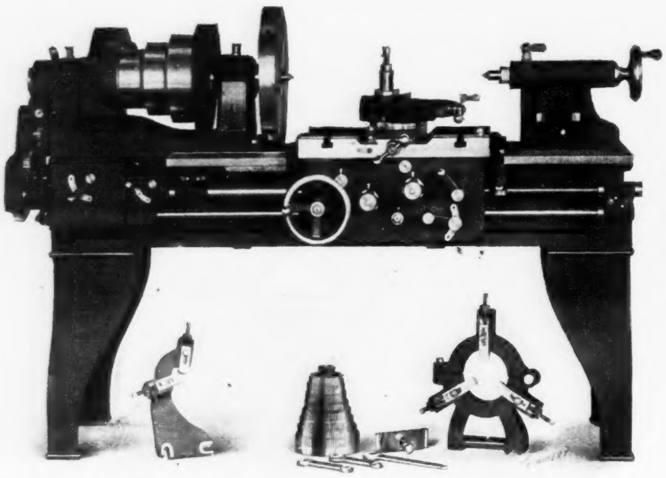
ROCKFORD 16-INCH LATHE

The lathe illustrated herewith is a 16-inch double back-geared design built by the Rockford Lathe & Drill Co., Rockford, Ill. This machine is constructed throughout to meet the conditions of modern shop practice. The bed is of deep section and has wide cross braces. The headstock is massive and is equipped with large bearings lined with the best quality of babbitt metal. The spindle is of high-carbon steel and is accurately ground. It has a 1½-inch hole extending the full length, and draw-in collets up to ¾ inch capacity may be used. The tailstock is of the offset type and has double clamping bolts to hold it securely to the bed. The carriage has a wide bridge and a bearing of 26¼ inches on the ways, with self-oiling felt wipers.

The thread cutting indicator is so arranged that it can be disengaged when not in use. The apron has a double bearing for all shafts. The gears are of wide face and coarse pitch and are cut from steel. The feeding movements are reversed

in the apron, and an interlocking arrangement makes it impossible to engage the feeds and lead-screw simultaneously. The gear box gives three quick changes of feed for each change of gearing, by means of sliding steel gears and hardened steel clutches. The gear box simplifies the thread cutting and the compounding of gears is avoided.

The regular equipment includes the follow- and steady-rests, large and small faceplates, a full set of change gears, double-friction countershaft and wrenches. Extra attachments are also provided, including a draw-in attachment and collets, taper attachment, turret for the carriage, and a turret on the shears, with or without power feed. The lathe swings over the ways 18½ inches, and over the carriage, 11¾ inches. The maximum distance between the centers (with a 6-foot bed) is



Rockford 16-inch Double Back-geared Lathe

28 inches. The ratios of the back gears are, respectively, 3.5 to 1 and 11.13 to 1. The thread cutting capacity varies from 2 to 96 threads per inch. The net weight of the lathe with a 6-foot bed, is approximately 2150 pounds.

JONES & LAMSON DOUBLE-SPINDLE FLAT TURRET LATHE

The Jones & Lamson Machine Co., Springfield, Vt., is now building a flat turret lathe equipped with two spindles. This double-spindle machine is not intended to displace the well-known single-spindle type built by this company, but it has been developed for producing large quantities of duplicate parts. It is designed primarily for chuck work and can be used as a single-spindle machine if desirable. When two spindles are employed for machining two duplicate parts simultaneously, considerably more time is required for setting up the machine than is necessary for the regular single-spindle type, but the increased rate of production obtained with the two-spindle design, more than offsets this initial handicap. The single-spindle machine is considered the best type for ordinary machine building operations, regardless of whether the work is turned from the bar or is of the chucking variety. On the other hand, the double-spindle type is preferable when work is to be produced in such quantities that the time for setting up the machine becomes a secondary consideration.

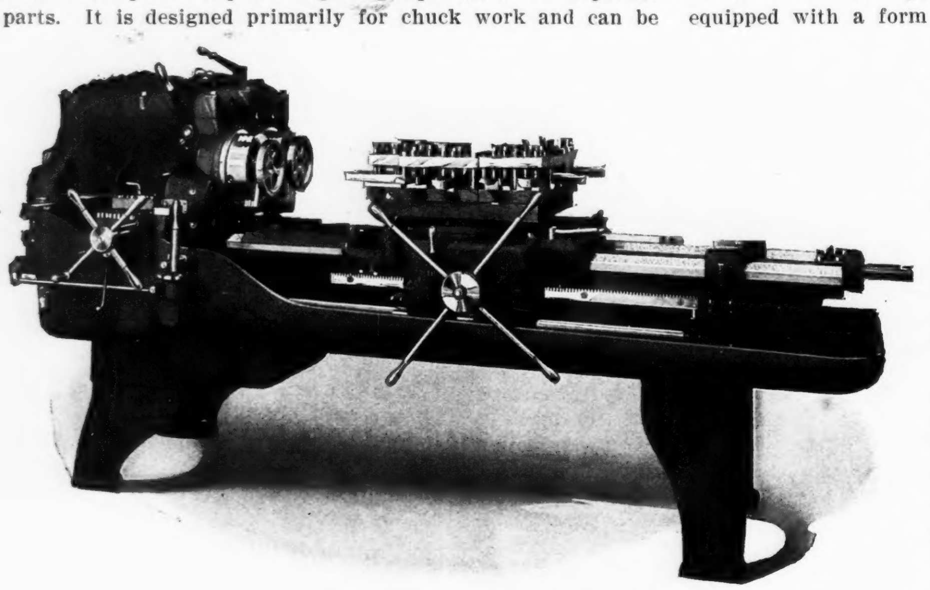


Fig. 1. Jones & Lamson Double-spindle Flat Turret Lathe

When the double-spindle machine is used as a single-spindle type, a chuck 17 inches in diameter is used, and when both

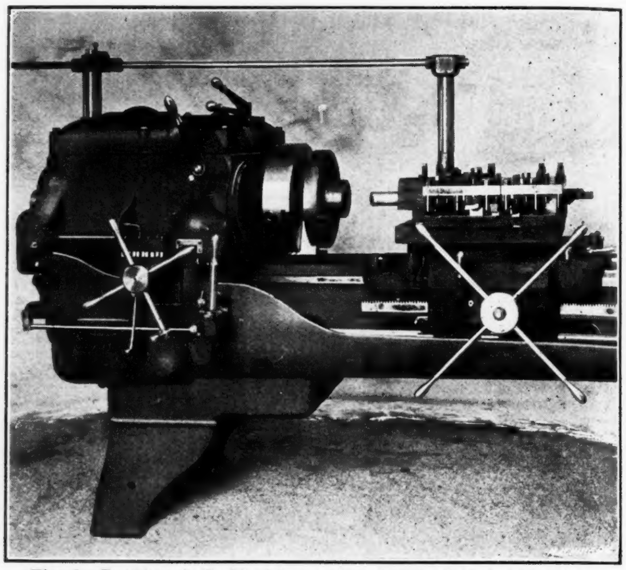


Fig. 2. Double-spindle Machine equipped with 17-inch Chuck for Single-spindle Operation

spindles are in operation, two 9-inch chucks are employed. Fig. 1, of the accompanying illustrations, shows a general view of the machine arranged for using both spindles, whereas, Fig. 2 shows it equipped with the 17-inch chuck for single-spindle operation. Fig. 3 shows the head and a section of the turret at close range. The general construction of the head is illustrated in the line engraving Fig. 4 which indicates the method of adjusting the main spindle for wear and the means provided for receiving the end thrust.

It will be noted that the head is supported by means of rolls *A* bearing upon the hardened steel rail *B*. To provide for vertical "take-up" upon this rail, there are eccentric rolls *C* which bear against the under side, as shown. The cross travel of the head is controlled by rolls *D* which bear against one side of rail *B*, while on the opposite side of the rail, eccentric rolls are similarly placed to provide a means of adjustment.

The two work spindles of the machine have bearings equipped with a form of bushing which enables play to be easily taken up. This arrangement consists of a taper sleeve *F* which bears against the bronze bushing *G*, and when it is necessary to take up wear, the taper sleeve is adjusted by means of the small pinion *H*. Both work spindles are operated by pinion *I* which meshes with the geared faces of the work spindles *J*. Upon this main spindle which supports pinion *I*, a small oil pump provides spray lubrication for the various parts.

The chucks are not attached to the main spindles by hubs of small diameter, in the usual manner, but in a more rigid way as illustrated in Fig. 5. The spindles of the machines, which, by the way, are steel forgings, are provided with heads of the same external diameter as the chucks. The outer end of the spindle *A* is threaded with a right-hand thread, and the inner end of the chuck or faceplace *B* (as the case may be), is threaded with a coarse left-hand thread of the same pitch. After inserting the driving pin *C* in sockets in the spindle and chuck or faceplate, respectively, a right- and left-hand threaded sleeve *D* is screwed on, thus bringing the outer face of the spindle and the inner face of the chuck or faceplate firmly together. To insure the chuck or faceplate being in

the proper position, a seat is bored in the spindle which receives a projection on the inner side of the chuck or faceplate. This construction insures an accurate mounting, and prevents the chuck or faceplate from getting out of alignment.

When the machine is to be used as a single-spindle type, thereby employing a 17-inch chuck and permitting large work to be done, the head of the front spindle is covered with a shield as shown in Fig. 2. In this manner, large chucking work may be easily and efficiently machined. The method of supporting this large chuck on the spindle is exactly the same as has been previously described, although the chuck, of course, extends out beyond the means of support.

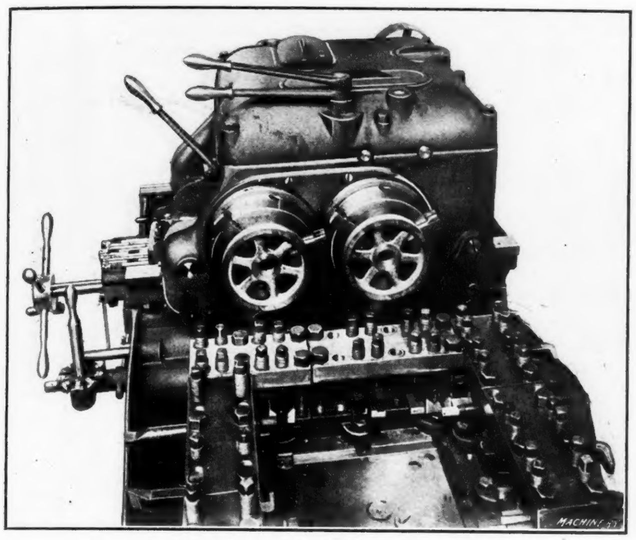


Fig. 3. Turret and Head of Double-spindle Turret Lathe

Fig. 6 shows the construction of the turret and tool-blocks. The general outline of the turret is square, and the tools are rigidly held, with a minimum amount of overhang, by means of the tool blocks and binding screws connected with the clamping plates. All of these parts are plainly shown in this illustration. Two duplicate sets of tools are clamped to each

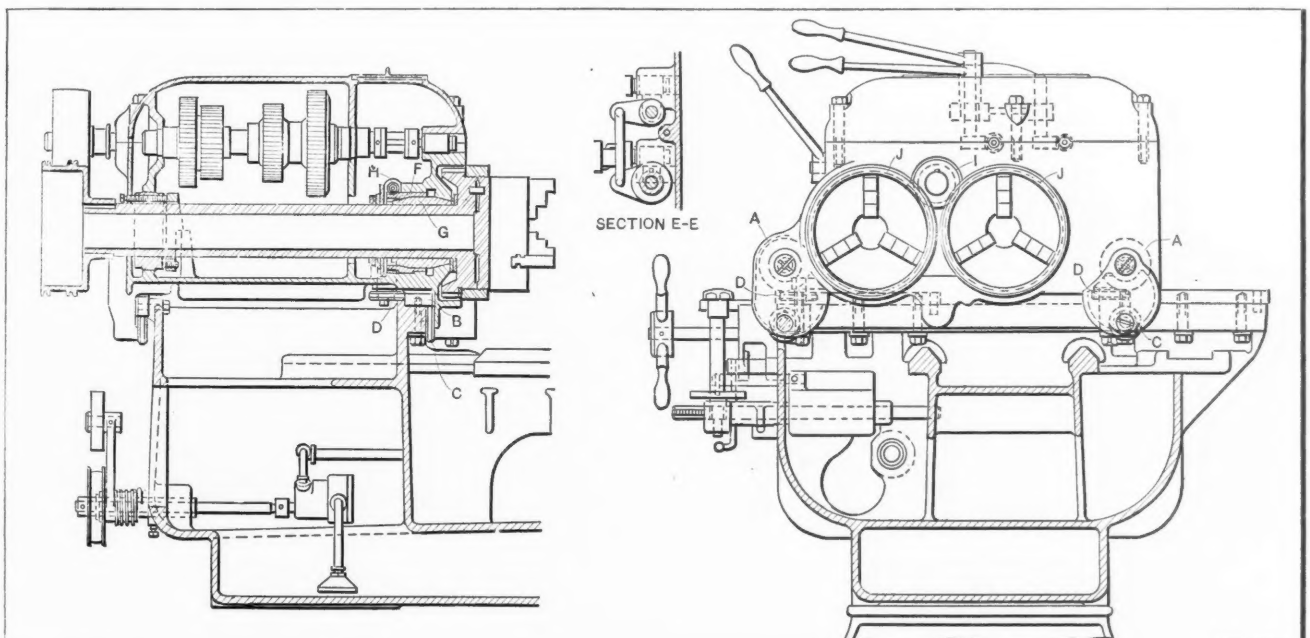


Fig. 4. Views showing the General Construction of the Headstock

side of the turret, and these operate simultaneously on the two pieces held in the chucks or on the faceplates. Primarily the turret is used in but four positions, but when a 17-inch chuck or faceplate is employed, corner blocks may be held by the clamping plates in which tools are supported, giving, if necessary, four additional operations by indexing the turret to eight positions. Provision is made for holding dies at one side of the turret, and each of the corner tool-holding fixtures may be moved to or from its companion tool-holder a slight amount, by means of elongated slots in which the binding screws are placed. As a matter of convenience, the clamping plates are held down by ¾-inch cap-screws, while the set-screws which hold the tools are ⅞ inch diameter. Thus it is possible to clamp through the set-screw holes if this should be necessary on account of a difficult "set-up." Hardened steel supports are provided to support the two inner ends of the turret while in operation. These supports obviate a great

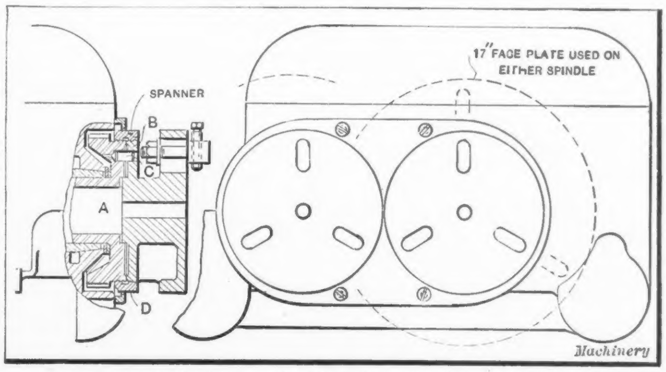


Fig. 5. Method of Supporting Chucks on Double-spindle Machine

deal of chatter and permit the tools to work more satisfactorily. On the under side of the turret, hardened seats are secured which rest upon the carriage supports.

A typical job to demonstrate the application of the double-spindle flat turret lathe is illustrated in Fig. 7. As may be seen, the work consists of sprocket wheels which are held in the two 9-inch chucks. At the first position of the turret, which is the one illustrated, the inside is rough-bored by tools *A*. At the second position of the turret, tools *B* rough-face the inner side of the flange; tools *C* face the outer side of the flange, while tools *D* turn the face of the flange. At the third position of the turret, tools *E* finish-turn the inside of the flange, tools *F* finish-turn the outside of the flange, while tools *G* finish the face of this flange. At the fourth position of the turret, tools *H* finish-bore the work; tools *I* complete the turning on the outside of the flange, while tools *J* accurately size the interior of the flange. It will readily be appreciated that the work done at the first position of the turret, can be accomplished in a much shorter space of time than that done at any of the other three positions.

With the double-spindle flat turret lathe, each operation is a double operation, and, moreover, it is not performed at the same speed; thus, if at one position of the turret, the tools are required to rough out the work, this may be done rapidly, for it has no bearing on the other operations that are subsequently performed. Furthermore, if the following operation has to be performed with great care, this may be done without reducing the speed of the less exacting operations.

A further demonstration of the advantages of a machine of this type involves the time factor. On some machines, of the automatic type, the time for producing any given piece is conceded to be the time of the longest operation performed; thus, if on a four-spindle automatic, the first operation requires 30 seconds, the second operation 30 seconds, the third operation 8 minutes, and the fourth operation 30 seconds, the

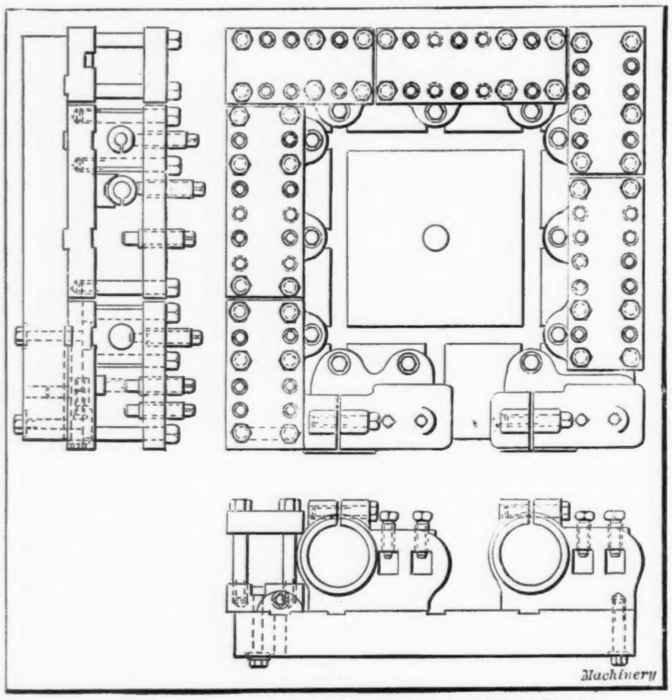


Fig. 6. Elevations and Plan View of Turret and Tool Blocks

time required to produce each piece with this machine will be 8 minutes. With the double-spindle turret lathe on similar work, the time required is the sum of the time of all of the operations divided by two. In this instance, therefore, the time for each piece would be 4¾ minutes, as contrasted with 8 minutes when performed on the multiple-spindle automatic.

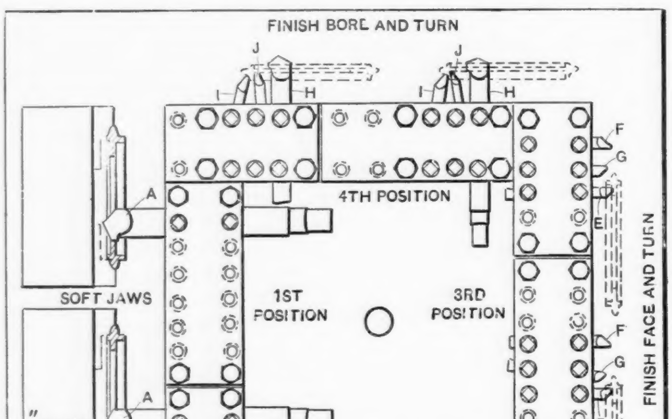


Fig. 7. Diagram showing Tool Equipment and Successive Steps in Machining Sprocket Blanks on Double-spindle Flat Turret Lathe

The double-spindle machine can be used advantageously in connection with the single-spindle flat turret lathe, the single-spindle machine being employed for general work, and the double-spindle machine for the manufacture of duplicate parts in quantity.

* * *

When a boss is made for bolt head or nut, it should be made at least one-quarter inch larger than the largest diameter of the bolt head or nut, so that the head or nut will have a full bearing, even if the hole be cored or drilled out of center.

NEW MACHINERY AND TOOLS NOTES

Filing Machine: Robinson Tool Works, Hartford, Conn. Bench filing machine having a square table which is adjustable for angular work. The stroke of the file may be varied from 0 to 2 inches. All the working parts are protected by a suitable cover.

Turret Head: Milliken Machine Works, West Newton, Mass. Ball turret head for converting ordinary lathe into a turret type, when machining work requiring a number of tools. The turret is held in the tailstock by means of a taper shank, and it is actuated by hand.

Tool Grinder: W. W. Blakely, 100 Leicester Court, Detroit, Mich. Attachment for grinding lathe tools, which is clamped to the ways of the bed and is driven by friction from the cone pulley. This grinder is intended to be used for sharpening tools while cuts are being taken, so that no time will be wasted.

Grinder Countershaft: Rivett Lathe & Mfg. Co., Brighton, Mass. Countershaft built for the grinders manufactured by this company. It is a complete unit and is made to fasten to the wall. The necessary speed changes are obtained by cone-pulleys, and the work-spindle driving-drum is controlled by a clutch so that the work may be stopped independently.

Bolt Cutter: H. B. Brown Co., East Hampton, Conn. Motor-driven bolt cutter built in two sizes, which have maximum capacities for diameters of ¾ inch and 1½ inch, respectively. The small machine is driven direct, and the larger size is equipped with gearing having a ratio of 5 to 1. These machines can be used for nut tapping as well as threading.

Coupling: Valley Iron Works, Williamsport, Pa. Interlocking jaw coupling having compressible sleeves and so designed that the power is transmitted by the jaws and not by the bolts which hold the two parts together. The principal features claimed for this coupling are: greatly increased strength, compensation for any inequalities in the shafts, proper alignment and the elimination of strain on the bolts.

Valve Grinder: McConnell-Browning Engineering Co., Richmond, Va. Hand-operated valve grinder for the grinding of gas or gasoline engine valves. The required reversing motion is obtained by a worm and sleeve, the latter being given a reciprocating movement by turning a crank. Means are provided for shifting the position of the valve on its seat while grinding, without removing the tool from contact.

Gear Hobber: Adams Co., 877 Market St., Dubuque, Iowa. No. 1 gear hobber capable of cutting spur gears, worm-wheels and spiral gears. This machine, in its regular form, will cut spirals of 8 degrees and under, and it can be modified to cut any angle desired, but cannot be adjusted to cut angles differing more than 8 degrees. This is claimed to be a very rigid and efficient machine and comparatively low in price.

Drill Socket: Scully-Jones & Co., 316 Railway Exchange Bldg., Chicago, Ill. Drill socket having a key on the inside and a keyway on the outside, extending almost the entire length of the socket. This gives a positive drive and eliminates the twisting of tangs either on the drill or the socket itself. A reinforcement at the base furnishes means for separating the sockets with a drift, and this type can be "nested" with any other make.

Bench Drill: Monarch Machinery Co., 249 N. 3d St., Philadelphia, Pa. Sensitive bench drilling machine with chuck having capacity for drills up to ¼ inch. The table is 8 inches in diameter and is mounted on a swinging arm. The table has a vertical movement of 7 inches, and the spindle a feeding movement of 4 inches. A two-step cone pulley provides two speeds, and an adjustable idler is used to vary the belt tension. The machine will drill to the center of a 10½-inch circle.

* * *

A WONDERFUL MACHINE

It is possible by the use of a few technical terms to make the description of a simple mechanism rather complicated. The following description of a new machine was supplied by a machinist in order to show how "big" words may complicate matters:

"Well," said James, "I went over and saw that new machine to-day, and it is astonishing the fine work it does. By means of a pedal attachment, a fulcrumed lever converts a vertical reciprocating motion into a circular movement. The principal part of the machine is a huge disk which revolves in a vertical plane. Power is applied through the axis of the disk, and while the speed of the driving arbor is moderate, the periphery of the apparatus is traveling at high velocity. Work is done on this periphery. Pieces of the hardest steel are by mere impact reduced to any shape the skillful operator desires."

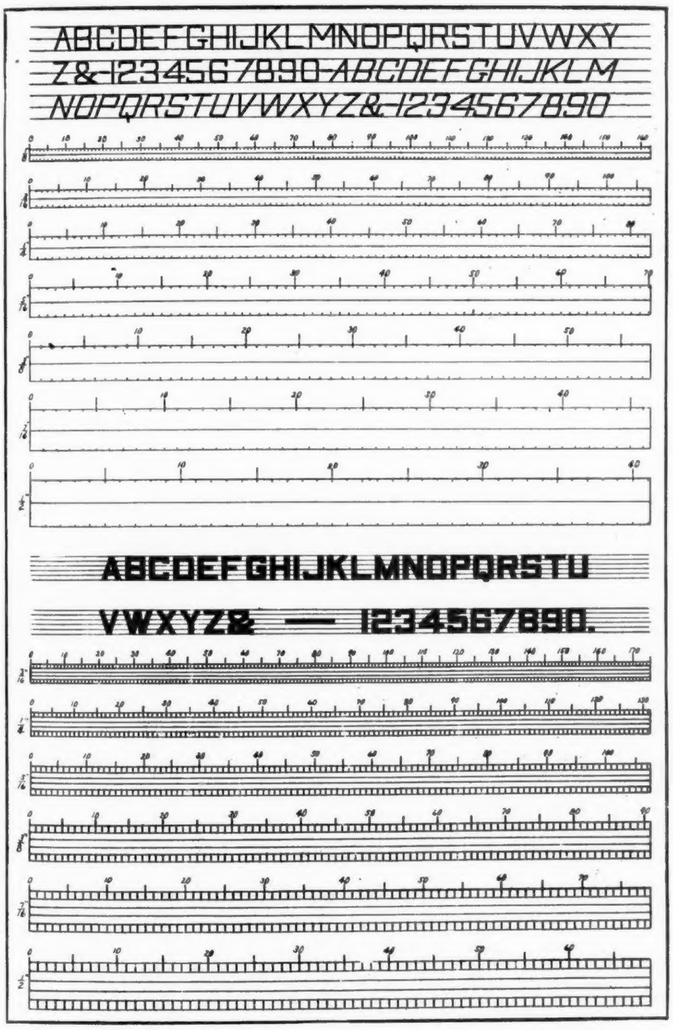
"What in thunder is that machine, anyway?" demanded Tom Briggs.

"Oh, it's a new grindstone," replied James, and a silence fell upon the group.

LETTERING TITLES

By E. J. G. PHILLIPS*

To produce a well executed title for tracings, having letters sufficiently large and bold to quickly attract attention, requires considerable time if done in the ordinary way. The method described in the following offers a way of producing very satisfactory titles in a relatively short time. The accompanying illustration is about a half-size representation of a master card, which if carefully prepared will serve as a convenient guide for laying out letters of various sizes, without the use of preliminary construction lines. It may be considered a tedious job to lay out this master card, but as this one layout will last for years, the time required is well spent. If the original is made on tracing cloth, a permanent vandyke negative may be made from it, and then black on white vandyke prints may be produced and mounted on cardboard in sufficient numbers to supply the entire drafting force.



Master Card for Laying out and Lettering Titles on Drawings

The upper half of the card is used for several styles of letters and figures from ⅛ to ½ inch in height; complete alphabets of two styles are shown, the first having vertical and the second slant letters. While the styles shown are very plain, more elaborate ones may be made from the same master card. For these letters the guide lines are laid out in the following proportions: the horizontal spaces are made equal to or one-third of the height and all letters are made two spaces wide, except M which requires three spaces, W, four spaces and I, one space. These proportions may not be exactly correct, but the writer believes that the alphabets given at the top of the illustration show reasonably good proportion.

The lower half of the card is used for block letters and figures from 3/16 to 1/2 inch high, as indicated at the left of each line. The usual proportions are used, *viz.* five spaces high and four spaces wide except M which requires five spaces, W, six spaces and I, one space. These guides may also be used for the Gothic letters as described in the March, 1910, number of MACHINERY. Every fifth vertical graduation is extended above the top line and every tenth graduation is numbered, convenient for locating a title in a certain space.

When the tracing is ready for the title, the master card is placed beneath the cloth, bringing the guides for the desired size of letters in their proper location, and then they are inked in. When slant letters are to be used, the triangle should be set so that when it matches one of the graduations in the top line, it will coincide with the next graduation to the left, in the bottom line.

When it is desired to locate a title in the center of a given space, the spaces required should be counted making the allowances previously given for each letter, and leaving one space between letters and four spaces between words. In this way the number of spaces required for the title can be quickly found, and by referring to the figures above each set of guide lines, the lettering can be begun at the proper place. On the other hand, if the space for the title is limited and it is desired to use the largest letters possible, first determine the number of spaces required; then by referring to the figures and measuring the length of the required number of spaces, the proper size of letters may be found.

* Address: 233 Park Ave., Aurora, Ill.

* * *

THAT RED-HAIRED BOY

By A. P. PRESS

We needed another boy in the office, and the boss put it up to me one day. "Say, Jim," said he, "get me a good boy—one that is *good* for something. Get a red-headed boy if necessary—only get him!"

I transmitted the request to the office, just as he told me: "Wanted—One good office boy. *Must be red-headed.*"

The hiring clerk called me up and tried to call me down for it, but I told him that if he didn't like it, he could have it out with the boss, for it was none of my funeral anyhow. I waited a week, but the boy did not show up. I knew I had to get him somewhere, so I commenced watching the trolley cars as I came down mornings; and one day, clinging to the rear end of the running board, I saw what I thought we wanted. So I dropped off the car at the same time he did.

"Where are you working, son?"

"Down at the shear shop, sir."

"What do you make a week?"

"Four fifty, sir."

"Would you like a job at six dollars if you could get it?"

"I certainly would, sir." (Always with the "sir.")

"Well, go down to the hiring office and ask the boss there if he wants a boy. If he says 'No,' take your hat off and say, 'Kindly look at my head, sir,' and he will will hire you."

The kid went, and from what the hiring clerk told me afterwards, I think he did just as he was told. He came to work and made good with the "old man" right off, and stayed with us nearly a year. Every noon after lunch he used to slide off into the die-sinking department and work away on the end of a piece of steel—die-sinking. One day I asked him what he was doing. He answered, "I am going to be a die-sinker bye and bye, and I am working it up now."

A few weeks after that (this I learned long afterwards) he wrote a letter to a silver shop, asking them if they wanted a boy to learn die-sinking, and if so, he would like to hear from them. The boy waited a couple of weeks, then went down to the shop and asked if the boss die-sinker was there. When the boss came out, the boy asked:

"Is there any chance for an apprentice, sir?"

"Not a bit," said the foreman, as he turned to go back.

"But look, sir," he persisted. "I have done a little in that line," and he pulled a piece of aluminum about four inches long from his pocket. It was all covered over with impressions from the lines and stamps he had cut. Now, I never saw a die-sinker who would not leave a funeral procession to look at a scrap of metal. This one was no exception to the rest of them, so back he came, looked over the sample, and it ended with his promising the boy a job later on.

The next night the boy gave notice, having landed the job. It is not difficult to look a little way into the future and see where that boy will be five or ten years from now. Following the mark he has set for himself, he is going to get there —and he will not always be sinking dies either.

MACHINING A FAN MOTOR CASE IN A BARDONS & OLIVER TURRET LATHE

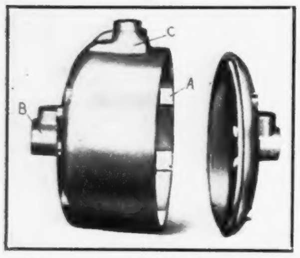


Fig. 1. Fan Motor Case to be machined

An excellent example of accurate turret lathe work is represented in Fig. 2, which shows the set-up used in machining the fan motor case shown in Fig. 1. This motor case is made from an iron casting with eight ribs cast on the inside circumference of the large hole, the remaining portions of the shell between the ribs not being more than ⅛ inch thick. The ribs *A* are to be machined, and a hole is to be drilled, bored and reamed in the shank *B*, which must be concentric with the large hole in the case to within a limit of 0.002 inch. When the shape and character of this casting are considered, 0.002 inch is a very close limit to attain, and can only be accomplished with a first-class tool equipment and considerable ingenuity on the part of the designer.

When being machined, the casting is gripped by the shank *B* in a spring collet, and is additionally driven by boss *C*, which fits in a slot in hood *A*, Fig. 2. Screwed into hood *A* are sixteen knurled thumb-screws *B* and *C*. These are used to support the casting during the roughing operations. The screws *B* in the circumference of the hood are opposite the projections or ribs on the casting, which are to be machined. The screws *C* in the rear of the cap are binder or tension screws for shank *B*, Fig. 1. The order in which the machining operations are carried on is very interesting, and it is due to this layout that such accuracy can be obtained.

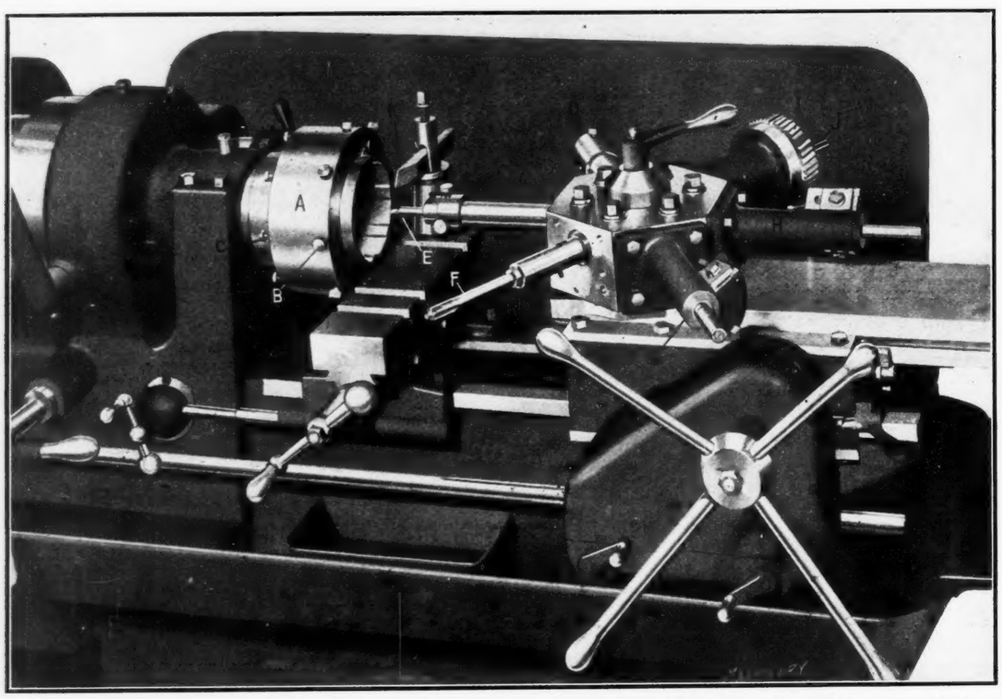


Fig 2. "Set-up" of Tools for Machining a Fan Motor Case in a Turret Lathe built by Bardons & Oliver, Cleveland

After the casting is placed in the chuck, the knurled screws *B* are tightened, centering the casting so that it will run practically true, and also holding it rigidly in the hood. The order of operations after the casting is placed in the chuck and the screws are tightened, is as follows: (Refer now to Fig. 2).

1. Drill small hole in shank *B*, Fig. 1, with drill held in holder *D* at a speed of 192 R. P. M. (open belt) and a feed of 0.0135 inch per revolution.
2. Bore small hole with boring tool *E* at a speed of 192 R. P. M. (open belt), feed 0.0135 inch per revolution.
3. Ream small hole with reamer *F* held in floating holder; speed 44 R. P. M. (with back-gears thrown in), feed by hand.
4. Rough-bore large hole with boring-tool *G* provided with two cutting tools; speed 44 R. P. M. (with back-gears thrown in), feed 0.020 inch per revolution.
5. Adjust knurled thumb-screws *B*, partly releasing their pressure on the casting.
6. Finish-bore large hole with boring-tool *H* provided with two cutting edges; speed 44 R. P. M. (with back-gears thrown in), feed by hand.
7. Again adjust knurled screws, leaving casting practically loose, and relieving all strains set up by the cutting tools.
8. Finish-ream large and small holes with reamers *I* and *J* (reamer *J* floating); speed 24 R. P. M. (with back-gears thrown in), feed by hand.

It is due largely to the manner in which this last operation is handled that the required accuracy is obtained. Here, it can be seen by referring to the order of operations, that the casting practically floats on the large reamer *I*, the small reamer *J* being guided by the hole which has been previously reamed and not removing any material, but simply acting as a "steady pin" for the large reamer. The cutting tools in the boring-tool holders *G* and *H* are spaced the same distance apart as the projections to be machined in the large hole, thus insuring rigidity and obviating chattering. The large hole is 5.505 inches in diameter and the small hole ¾ inch in diameter. The casting is faced off with the turning tool *K* held on the cross-slide, this operation being accomplished while the boring-tool *G* is at work. The time to complete one case is thirteen minutes, including clamping the work and machining.

* * *

ANNUAL MEETING OF THE N. M. T. A.

The fourteenth annual meeting of the National Metal Trades Association was held in New York City, April 11, at the Hotel Astor. The meeting was remarkable for the despatch with which the business was transacted, the public program, including the reading of several papers of length, being carried through in one day. The banquet given to the members and guests in the evening, at which speakers of international fame spoke on the tariff, universal peace and education, was a notable affair, giving a member of the president's cabinet an opportunity to voice sentiments regarding protection and free trade of extraordinary public interest. F. C. Caldwell of H. W. Caldwell & Son Co., Chicago, the president of the association, presided, assisted by Robert Wuest of Cleveland, the commissioner, who has well demonstrated his ability to conduct the affairs of this association of over seven hundred manufacturers of metal products.

The program included the valuable reports: "Systematic Compensation for Industrial Accidents," presented by Henry D. Sharpe, president of Brown & Sharpe Mfg. Co., and "Industrial Education," presented by F. A. Geier, president of the Cincinnati Milling Machine Co.; the papers "Prevention of Industrial Accidents," by William H. Doolittle, the association's safety inspector; "Employer's Liability and Workmen's Compensation—What has been done to Date and is now doing in It," by Miles H. Dawson, attorney and consulting actuary, New York City; "How far must Business Yield to the Demands of Industrial Organizations?" by Hon. J. J. Feeley, of Boston; the reports of Commissioner Robert Wuest, and Assistant Commissioner H. E. Herrod, and other reports on the various activities of the association.

The report on industrial education comprised the Hartford, Cleveland, New Haven, St. Louis, Chicago, Springfield, New York and New Jersey and Cincinnati branches, all of which are doing effective work in educating boys. The cooperative course in engineering in Cincinnati has been in operation six years and three hundred are taking it. This year thirty-five will graduate and take positions as assistant engineers and foremen, and other executive positions. A new building has been added which will increase the capacity of the school to four hundred. The Cincinnati continuation school work has

been extended to include the apprentices employed in the allied printing trades. Notwithstanding the depression in business, the attendance has been two hundred.

Mr. C. A. Prosser, the recently appointed secretary of the National Society for the Promotion of Industrial Education, spoke on the Page education bill, which carries an appropriation of $14,000,000. This bill to extend Federal aid to industrial education was primarily intended to help agriculture, and Mr. Prosser pleaded that the bill might be given a scope that would comprehend industrial education generally. He argued that the moral effect of Federal aid would be to make young men generally look upon the industries in a more favorable light and thus reduce the crowding in the so-called "genteel" occupations.

The report on industrial accidents by Mr. Doolittle is a painstaking paper describing a large variety of conditions in shops, mills and factories likely to cause accidents to workmen. Stereopticon views showed practical protective devices for machine tools, presses, saws, elevators, etc., which have been provided in the plants of members of the association.

The paper by Mr. Dawson, of which a full abstract appears in another part of this number, is a summary of the changes made in the relation of employers and employes in the United States and abroad by legislative enactment of employers' liability and workmen's compensation laws. The progress of this movement during the past two years is remarkable, and it foreshadows the time, comparatively close at hand, when every industry will be required to directly bear the burden of workmen's disabilities resulting from their occupations.

Judge Feeley's paper on the relations of capital and labor, defines a strike and what constitutes an unjustifiable strike under the laws of Massachusetts; also a lawful strike, methods of enforcing a strike, the sympathetic strike and the boycott.

The speakers at the banquet were Hon. Franklin MacVeagh, secretary of the treasury who spoke on the tariff; Hon. W. Morgan Shuster, formerly treasurer of Persia, whose theme was international peace; and Dr. Arthur A. Hammerschlag, of Pittsburg, a noted exponent of industrial education.

The officers elected for the ensuing year are:

President, Henry D. Sharpe, of Brown & Sharpe Mfg. Co., Providence, R. I.

First vice-president, W. A. Layman of Wagner Electric Mfg. Co., St. Louis, Mo.

Second Vice-President, L. H. Kittredge of the Peerless Motor Car Co., Cleveland, Ohio.

Treasurer, Howard P. Eelles of the Bucyrus Co., Cleveland, Ohio.

* * *

SINKING OF THE TITANIC

The sinking of the White Star Steamship *Titanic* on her first voyage is the most appalling of the long roll of disasters on the sea. Though built with all the safeguards that human ingenuity could devise, collision with an iceberg off Cape Race, Newfoundland, just before midnight, April 14, so crushed the hull that in less than three hours she had sunk in one of the profound depths of the Atlantic, carrying down 1600 of the passengers and crew and millions in treasure. The boasted security of the modern steamship seems a hollow mockery in the face of this catastrophe—so great that it stuns the intelligence and sickens the imagination. A great vessel of 46,000 tons registered, the largest ever built, was lost by an accident that everyone familiar with the perils of the sea knew to be possible, but which few supposed could be so disastrous as this.

Out of this appalling disaster the wireless telegraph emerges triumphant. Without this wonderful means of communication few, if any, would have survived to tell the awful tale. Although but a few hours in the boats before they were picked up by the *Carpathia* of the Cunard line, several of the 700 died of shock and the intense cold. Had life boats been available for all and had there been time to embark in an orderly way, the loss of life even then would have been severe. Many more lifeboats are needed but will be futile unless both crew and passengers are drilled to act systematically in emergencies, each going to his appointed place on signal. But important as are lifeboats and lifeboat drill they are secondary. The business of steamship companies is transporting passengers from one port to another—not dumping them into small boats to perish in the open sea. Let us devote more thought to making vessels stronger and safer, to the construction of bulkheads that will stand the greatest water pressure that can be imposed on them, to the design of bulkhead doors that will promptly close in emergencies, to the personnel of the crews and finally to navigation laws that will stop this reckless trifling with death in taking the risks of the shorter route and running at full speed when icebergs are moving down from the North.

* * *

AN ACCESSION TO MACHINERY'S STAFF

We are glad to announce that Mr. William Ledyard Cathcart has become a member of MACHINERY'S editorial staff in the capacity of consulting engineer. Mr. Cathcart will devote particular attention to problems in mechanics and machine design, and to the preparation of a series of reference books on machine shop practice and machine details, which he is especially qualified to edit.

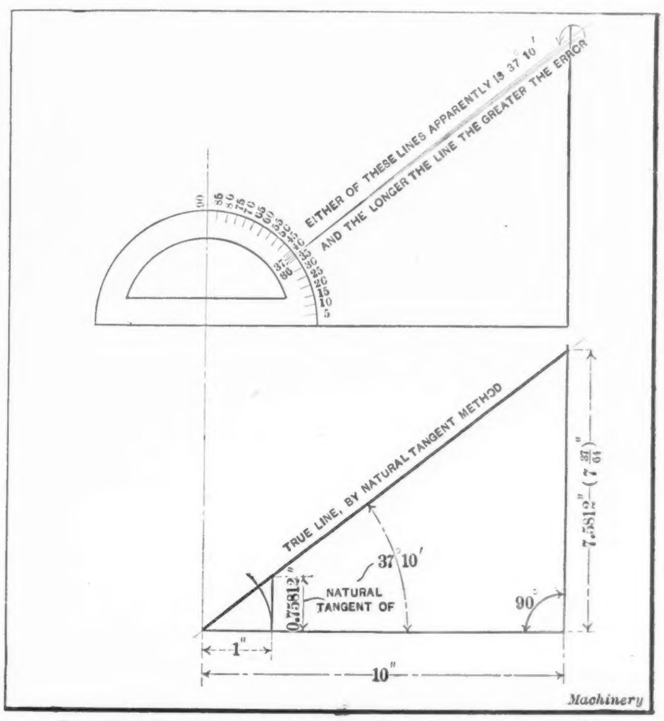
Mr. Cathcart is a graduate of the University of Pennsylvania and the United States Naval Academy, and following his graduation served sixteen years as an officer of the engineering corps of the United States Navy. During the Spanish-American War he volunteered for service, was appointed chief engineer in the Navy and ordered to special duty at Washington on the staff of the late Admiral Melville, then engineer-in-chief. Mr. Cathcart spent two years as professor of marine engineering; four years as adjunct professor of mechanical engineering, Columbia University; seven years as treasurer of a textile manufacturing company; five years with the Babcock & Wilcox Co., New York, translating, collating and analyzing scientific data from French and German sources. Prof. Cathcart is the author of "Machine Design," "Fastenings" and co-author with Prof. J. Irvin Chaffee of "The Elements of Graphic Statics."

* * *

LAYING OUT ANGLES ACCURATELY

By HARRY B. WRIGLEY*

In laying out an angle by an ordinary circular protractor, it is evident that a slight error at the circumference of the protractor will be multiplied many times in plotting a long line. The angle can be laid out accurately by the "natural



Two Methods of Laying Out Angles—Note the Advantage of the "Natural Tangent" Method

tangent" method. To illustrate, assume that it is necessary to lay out an angle of 37 degrees, 10 minutes. The natural tangent is 0.75812, and as this represents the altitude in inches of a right angle triangle having a base 1 inch long, the alti-

* Address: Care of Y. M. C. A., Allentown, Pa.

tude having a base 10 inches long will be ten times the natural tangent or 7.5812 inches (7 37/64 inches). It is evident that it is only necessary to find the natural tangent of the angle and multiply it by 10 which is equivalent to moving the decimal point one place to the right, in order to obtain the altitude when the base is 10 inches. A 10-inch base is taken as a matter of convenience, as it simply means moving the decimal point as described. The two methods of laying out angles—by means of the protractor and natural tangent—are shown in the accompanying illustration, where it can be seen that the angle can be laid out much more accurately by the latter method.

[A similar method for laying out angles accurately, but which employed the use of the sine, was illustrated and described in MACHINERY, June, 1911. It is evident that any of the functions of a right angle triangle—sine, cosine, tangent, or cotangent—can be used for laying out angles. Some prefer the sine, as the sine of half the angle is equal to half the chord.—EDITOR.]

* * *

PERSONALS

J. C. Ward, director and general manager of Edgar Allen & Co., Ltd., Chicago, departed April 21 for a business trip in Japan. Mr. Ward expects to be gone for several months.

F. B. Jacobs, who for the past year has been traveling for the Carborundum Co., Niagara Falls, N. Y., gathering data on shop practice, has entered the company's store at Philadelphia as a salesman.

E. Hawkinson, foreman in the toolmaking department of the Canadian General Electric Co's. plant at Peterboro, Ont., for the last three years, has resigned his position to take the position of tool designer for the Russell Motor Car Co., of Toronto.

William W. Bishop, for six years manager of the machinery department of the Cincinnati Iron & Steel Co., Cincinnati, Ohio, has resigned his position to become associated with the sales department of the Shaw Electric Crane Co., with headquarters in Chicago.

George Langen, works manager of the Cincinnati Planer Co., who intended to start in March for an extended European trip, was stricken with appendicitis two days before his sailing date. Mr. Langen is recovering, but his trip has been indefinitely postponed.

Ralph E. Flanders, of the Fellows Gear Shaper Co., Springfield, Vt., formerly associate editor of MACHINERY, addressed the American Society of Swedish Engineers, Brooklyn, N. Y., April 20, on the subject: "Scientific Management from a Social and Economic Standpoint."

Selbert M. Connor, heretofore an engineering draftsman with one of the large railroads terminating in Chicago, has started in business for himself, having opened an office at 414 Sherman St. Mr. Connor will undertake drawing, mapping and the execution of commissions for patterns, model work or any work of a mechanical nature.

A. N. Goddard (W. P. I. '99), for thirteen years with the Morgan Construction Co., Worcester, Mass., as assistant superintendent, recently resigned his position to become superintendent with the Union Twist Drill Co., Athol, Mass. When leaving the Morgan Construction Co., the employes presented him with a solid gold watch and guard suitably engraved.

E. F. Lake, formerly steel editor of the *American Machinist*, who for the past year has been conducting a consulting metallurgical business in Bayonne, N. J., has been placed in charge of the laboratory of the Perfection Spring Co., Cleveland, Ohio. Mr. Lake has contributed a number of valuable articles on alloy steels, extrusion of metals and die-casting machines to MACHINERY.

R. S. Bryant has been appointed consulting engineer of the Standard Welding Co., Cleveland, Ohio. Mr. Bryant was formerly with the Bryant Rim Co., of Columbus, Ohio, and his long experience in the design and manufacture of automobile rims peculiarly fits him to carry out the company's policy of constantly improving its products and service, as well as keeping its automobile rim designs in every way up to the latest requirements of the trade.

George Sherwood Hodgins, a well-known writer on railway topics, at one time editor of the *Railway Digest* and later of *Railway and Locomotive Engineering*, has been engaged by the commissioners of the Trans-Continental Railway of Canada to make a special report concerning the shop equipment of the various roundhouses, terminal shops, etc., now built or being constructed on that line. Mr. Hodgins will be engaged for several months on this work.

Frederick A. Hall, engineer, 5-9 Beekman St., New York, announces that Mr. Mancius S. Hutton is associated with him in the management of the office and conduct of the business. Mr. Hutton, who is the son of Prof. F. R. Hutton, honorary secretary and past president of the American Society of Mechanical Engineers, will have general charge of correspondence regarding the business, and will give special attention to the departments of boilers, engines and power equipment in which Mr. Hall acts as the direct representative of manufacturers.

Dr. Rudolf Diesel of Munich, Germany, director of the Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo., came to New York April 6 on the steamer *Amerika*. He will make a tour of the United States, lecturing before engineering societies and other bodies on the possibilities of the internal combustion engine. He is the inventor of the Diesel engine which is displacing steam engines in Europe for industrial purposes, and is being applied as the motive power of marine vessels with success. Dr. Diesel predicts that the internal combustion locomotive will eventually displace the steam locomotive because of its superior economy and simplicity. He was made an honorary member of the American Society of Mechanical Engineers, April 30, at the meeting of the gas power section. The conferring of honorary membership was followed by an illustrated lecture by Dr. Diesel on the development of the Diesel engine.

OBITUARIES

Frank B. Manville, an inventor of automatic machinery for making wire goods, and one of the organizers of the E. J. Manville Machine Co., Waterbury, Conn., died at his home in Waterville, Conn., March 29, aged sixty-two years. Mr. Manville invented machinery for making hooks and eyes, threading bicycle spokes by the rolling process, and forming rims for bicycle wheels. He also invented a brass shoe lace hook. He had worked in the Winchester, Colt, Whitney and Ames armories, and at the Elgin watch factory. Although one of the organizers of the E. J. Manville Machine Co., he was no longer connected with that concern. A widow and three brothers survive him.

Stanley K. Fox, machine demonstrator for the Gleason Works, Rochester, N. Y., was lost in the wreck of the *Titanic*, April 15. He helped the women and children into the life boats until the last one was filled and then calmly awaited his fate. Mr. Fox was thirty-eight years old, and was twenty-eight when he made his start with the Gleason Works without mechanical training. He soon became an expert machine operator, excelling all others in setting up work rapidly. Soon he was sent out to demonstrate machines and made many friends by his enthusiasm and kindly nature. He made his first European trip four years ago and was abroad last year from June to October and went again on the last trip in January. A memorial service was held in St. Andrew's Episcopal Church, Rochester, April 20, in which Rev. Dr. Thomas paid a high tribute to Mr. Fox's sterling qualities.

* * *

COMING EVENTS

May 9-18.—First Annual Aeronautical Exhibition held in the Grand Central Palace, New York City, under the auspices of the Aero Club of America.

May 13-15.—Triple joint convention at Norfolk, Va., of the American Supply and Machinery Manufacturers' Association, National Supply and Machinery Dealers' Association, and Southern Supply and Machinery Dealers' Association. The program includes papers on "Workmen's Compensation"; "Motion Study"; "The National Banking and Currency Problem"; and "The American Merchant Marine." F. D. Mitchell, secretary-treasurer, 309 Broadway, New York.

May 13-25.—Newark industrial exposition under the auspices of the Board of Trade of Newark, N. J., in the First Regiment Armory. It is claimed that one hundred thousand different articles are manufactured in the three thousand shops of the Newark industrial district, the diversity being proportionately greater than that of any other manufacturing district in the country. William G. Rose, manager, Newark, N. J.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Building, Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

May 16-17.—Semi-annual convention of the National Machine Tool Builders' Association at Atlantic City, N. J., Hotel Chalfonte headquarters. E. P. Bullard, Jr., president, Bridgeport, Conn.; James H. Herron, secretary, Cleveland, Ohio.

May 20-22.—Railway Storekeepers Association's convention in Buffalo, N. Y. Hotel Statler, headquarters. Wm. E. Kelley, secretary-treasurer, 825 Wabash Ave., Chicago, Ill.

May 27-31.—International Safety Congress to be held at Milan, Italy. Dr. W. H. Tolman, director of the American Museum of Safety, 29 W. 39th St., New York City, is a delegate to the congress from the United States.

May 28-31.—Spring meeting of the American Society of Mechanical Engineers in Cleveland, Ohio. Hotel Hollenden, headquarters. Calvin W. Rice, secretary, 29 W. 39th St., New York.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

June 17-22.—First annual gas engine show under the auspices of the National Gas Engine Association in the Auditorium, Cleveland, Ohio. Albert Stritmatter, secretary, Cincinnati, Ohio.

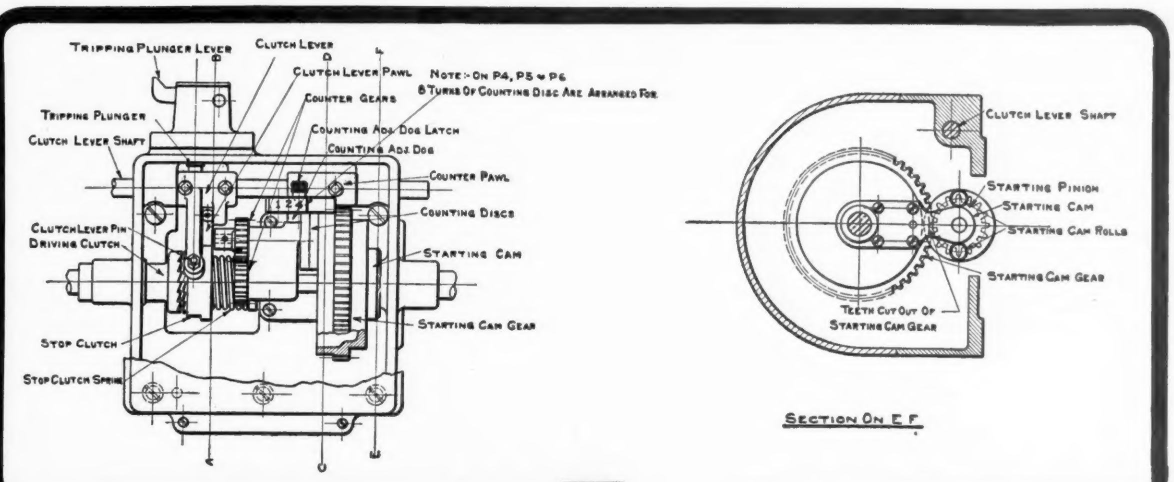
July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

Study these Diagrams of the Mechanism that Indexes Gears so Accurately and Quickly

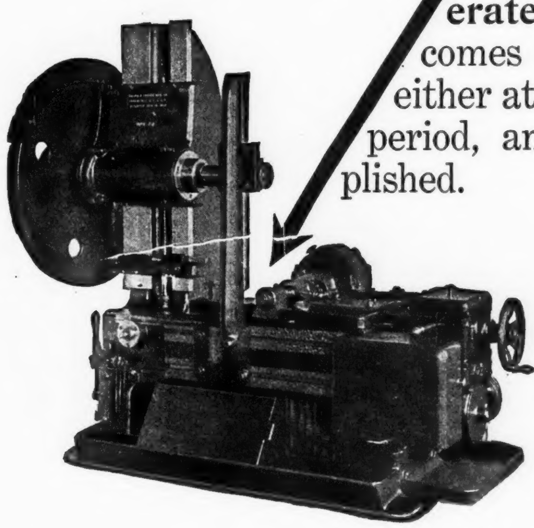


The indexing mechanism on a gear cutting machine is a feature of great importance.

It should not operate with a shock, for that will cause the spacing of the gear teeth to be inaccurate. Neither should it operate too slowly, for that will impair the production of the machine.

The indexing mechanism on B. & S. Automatic Gear Cutting Machines overcomes both of these difficulties because of certain exclusive features in its design.

At each indexing, the mechanism **starts slowly, is accelerated and then retarded** just before it comes to a stop. Hence there is no shock either at the beginning or end of the indexing period, and the operation is quickly accomplished.



Rapid, accurate indexing, together with other excellent features in design, enable a high rate of production to be obtained with B. & S. machines.

Write for special circulars of these machines.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Columbia University, New York, has issued an announcement for the Summer session for 1912, beginning July 8 and continuing until April 16.

American Society of Engineer Draftsmen, 116 Nassau St., New York City. Year book containing the constitution and by-laws governing the society; also list of members.

Beloit College, Beloit, Wis. Sixty-fifth annual catalogue of the college, containing information relating to the faculty and students, the courses, admission requirements, scholarships, etc.

Virginia Polytechnic Institute, Blacksburg, Va. Bulletin, April, 1912, covering 172, 6 by 9-inch pages, giving courses of instruction, and general information useful to prospective students, as well as a list of students for the year 1911-1912.

Louisiana State University, Baton Rouge, La. Bulletin giving information relative to the summer school of the university. The term of this summer school begins June 3 and ends August 2. The courses of instruction, admission requirements, fees, etc., are dealt with in this bulletin.

Modern Systems Correspondence School, 6 Beacon St., Boston, Mass. Booklet entitled, "As Others See Us," being an extract from an article in *Castings* on specialized correspondence schools. This school, of which Mr. Oscar E. Perrigo is director, specializes its courses to meet the needs of individuals.

Society of Automobile Engineers removed its New York office from No. 1451 Broadway to the U. S. Rubber Bldg., Broadway and 58th St., May 1. The growth in membership and activities of the society made necessary the removal to larger quarters. The new location will be appreciated by out-of-town members, being close to the Columbus Circle subway station and on the route of the Broadway surface car lines.

Northwestern University, Evanston and Chicago, Ill. Annual catalogue 1911-1912, covering 515, 6 by 9-inch pages, containing complete information of the various departments of the University, including the College of Liberal Arts, the College of Engineering, and the School of Commerce, and information relating to fraternities, university societies, alumni association, register of students, and general information relating to expenses, fees, etc.

American Association for Labor Legislation, Metropolitan Tower, New York City, is entitled to much credit for the enactment of the phosphorus match bill signed by President Taft, April 9. Investigation of "phossy jaw," the occupational disease of match factory workers, led to the introduction of the bill in June, 1910, immediately after the publication of the report on phosphorus poisoning by John B. Andrews, secretary of the association. Public sentiment demanded the prohibition of the death-dealing match. Through this legislation one of the most terrible of occupational diseases will be abolished.

NEW BOOKS AND PAMPHLETS

Electric Power on the Farm. By Adolph Shane. 62 pages, 6 by 9 inches. 31 illustrations. Bulletin No. 25 of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.

Second Annual Report on the Statistics of Express Companies in the United States, for the year ending June 30, 1910. 38 pages, 8 by 10 inches. Published by the Interstate Commerce Commission, Washington, D. C.

Kerrawalla's Textile and Engineering Directory and Year Book. 10 by 13 inches, 111 pages. Published by C. D. Kerrawalla, Kalachowki Road, Parel, Bombay, India.

The Textile and Engineering Directory and Year Book for 1912 is the seventh issue. Among the useful information contained are complete lists of cotton ginning and pressing factories, jute presses, cotton jute, woolen and silk mills, iron works, gold, copper, iron, lead, manganese, ruby, salt and coal mines, flour, sugar, oil, rice, saw, bone and paper mills, quarries, coil works, roperies, mica works in India, cotton mills in China and Japan together with a number of useful tables for mill and factory owners, managers, engineers, carding, spinning and weaving masters, hardware and mill store merchants, etc. The directory is freely circulated among the users of textile and engineering machinery in India and is, therefore, of special interest to manufacturing concerns who wish to reach this trade.

Transportation Rates. By A. M. Fisher. 16 pages, 5 by 7½ inches. Published by the author, New York. Price 50 cents.

This comment upon transportation rates, it is stated, has been written with particular reference to the section of the Interstate Commerce Act which is properly known as the "long and short haul" clause. The booklet is written from an extremely one-sided point of view, in which the opinions of the old-time "stand-pat" railway managers' ideas only are considered. As an example of the spirit of the booklet the following statement may be quoted: "It need not be anticipated that there will be a general revival of business with the present Interstate Commerce Act in effect and enforced." Digressing somewhat from the avowed purpose of the book, the author mentions that "it is hardly to be expected that profitable methods can be devised for the operation of the subways and other urban transportation service." It is difficult to understand on what basis this statement is made, in view of the fact that financiers seem to be extremely anxious to obtain monopolies in transportation services in cities, subways included. Another example of the peculiar mental processes by means of which the conclusions in this booklet are arrived at is the statement that the result of a parcels post would be "a very decided influence toward increasing the cost of living." The author finally advocates the introduction of scientific transportation rates. Just what he means by "scientific" is not entirely clear, but may perhaps be surmised from the few quotations given above.

NEW CATALOGUES AND CIRCULARS

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 147 on Crocker-Wheeler electric fans.

Detroit Fuse & Mfg. Co., Detroit, Mich. Revised bulletin No. 23 on the "Detroit" three-phase motor starter.

Studebaker Automobile Co., South Bend, Ind. Bulletin No. 1023 on electric commercial motor vehicles for all purposes.

Damascus Bronze Co., Pittsburg, Pa. Pamphlet on "Damascus" bronze products with special reference to bearings.

Detroit Fuse & Mfg. Co., Detroit, Mich. Catalogue of the "Detroit" ironclad fused switches and the "Arkless" indicating fuses.

Hannifin Mfg. Co., Chicago, Ill. Catalogue of air-operated chucks, countershafts, gate valve seating chucks, special tools and machinery.

Rockford Iron Works, Rockford, Ill. Circular and specifications of the Rockford inclinable open-back foot press, size A; also No. 4 flywheel press.

General Fire Extinguisher Co., Providence, R. I. Bulletin on the "Grinnell" automatic sprinklers for the protection of shops, mills and factories from fire.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Catalogue of lathe dogs, C-clamps, machinists' clamps, planer strap clamps, drop-forged wrenches, drop forgings, etc.

F. O. Weydell, 224 S. Jefferson St., Chicago, Ill. Circular of the "Hi-Low" drawing table which can be quickly changed in height from 36 to 44 inches to suit the convenience of the draftsman.

American Tap & Die Co., Greenfield, Mass. Catalogue No. 4 of "Adamantine" screw plates; "Eagle" brand taps, dies, stocks and tap wrenches; and pipe tools, comprising stocks, dies, taps and reamers.

Autocall Co., 100-110 Franklin Ave., Shelby, Ohio. Card illustrating the "Autocall" and its application in the manufacturing establishments for locating foremen, superintendents and others without loss of time.

Francis Reed Co., Worcester, Mass. Circular of the No. 20 Stanley sensitive drill having six spindle speeds, detachable countershaft, ball thrust bearing for spindle, ample power for one-half-inch drill and which sells for $50.

Brown Hoisting Machinery Co., Cleveland, Ohio. Pamphlet illustrating and describing "Brownhoist" suspended bins for coal, ore, ashes, etc., and catalogue of the "Brownhoist" tramrail systems, trolleys and electric hoists.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins, Nos. 1009 on push buttons; 1016 on automatic motor starters for non-reversing direct-current motors; 1025 on lifting magnets; and 1027 on current limit panels for direct-current motors.

Universal Stamping Co., Buffalo, N. Y. Bulletin illustrating safety devices made to prevent the flying of chips from shaper tools, lathe tools and other cutting tools, emery wheel guards, safety belt hanger, snap-on reflectors, lamp shades, lamp stands, etc.

Chicago Pneumatic Tool Co., Chicago, Ill. Bulletins, E-19, E-20, E-21 and E-22 on universal electric drills, operating on direct or alternating current; electric drills for heavy work; Duntley track drill; and air-cooled direct current drills, respectively.

Pawling & Harnischfeger Co., Milwaukee, Wis. Booklet entitled, "Cutting the Cost of Lumber Production," illustrating handling and transporting apparatus built by the company, comprising monorail systems, traveling electric cranes and hoists and electric transfer cars for handling lumber in bulk.

Watson-Stillman Co., 192 Fulton St., New York, has just issued catalogue No. 85 "Hydro-Pneumatic Wheel Presses," which describes and lists the company's line of full hydro-pneumatic wheel presses. Seventy-six types and sizes of hydraulic tools exclusively of Watson-Stillman designs are also listed.

Scully Jones & Co., 316 Railway Exchange, Chicago, Ill. Circular of the "Wear-ever" sockets for drills. The sockets are made of special steel, heat-treated, and reinforced at the bottom by a solid ring of metal of increased diameter having a drift groove which saves time in separating nested sockets.

Bausch & Lomb Optical Co., Rochester, N. Y. Circular of the "Balopticon" for the projection of large opaque objects on a screen. This instrument is designed for educational purposes and enables a lecturer to project drawings, photographs, working models, mechanisms, etc., directly on the screen without previous preparation.

Eureka Co., North East, Pa. Price-list of copper hammers for machine shop use, furnished in sizes from ¼ pound to 16 pounds, with or without handles. Copper hammers are more durable than babbitt hammers and have the characteristic of not seriously marring steel or cast iron when employed for driving or hammering work.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 60 on indicating gages for all purposes comprising pressure and vacuum gages, compound, ammonia, pyrometer, test, hydraulic, electric alarm, altitude, sulphite, illuminated dial, standard duplex and triplex, and recording gages, thermographs, marine and locomotive clocks, etc.

Watson-Stillman Co., 192 Fulton St., New York. Bulletin J describing a filling liquid, called "jackohol," developed for hydraulic tools such as jacks, presses, punches, benders, etc. This liquid does not freeze, thicken, gum or change chemical composition. It is invariably protective to the metal surfaces and packings with which it comes in contact.

W. P. Davis Machine Co., Rochester, N. Y. Treatise on keyseating and keyways compiled for American machine shop practice. This interesting and valuable little booklet contains a fund of useful information on a very practical subject affecting everyone having to do with the design and construction of machinery. The booklet also illustrates the Davis keyseater made in two sizes.

Pratt & Whitney Co., Hartford, Conn. Wall hanger of machinists' handy tables comprising U. S. standard screw threads, standard dimensions of wrought iron, welded tubes, table of cutting speeds and feed per minute, metric standard screw threads, pitch or angle diameters of hand taps, U. S. and Whitworth standard and A. S. M. E. standard screw threads for machine screws.

Furnace Gas Consumer Co., Matteawan, N. Y. Pamphlet entitled "Smokeless Chimneys," describing a furnace gas consumer for the prevention of smoke, consisting of a bank of fire clay tubes installed back of the bridge-wall underneath the boiler which becomes incandescent and thus promotes complete combustion of the gases before they are cooled by contact with the water-backed surfaces.

Keuffel & Esser Co., Adams and Third Sts., Hoboken, N. J. Descriptive circular of an improved farm transit with and without compass for the use of builders, architects, instructors, farmers, etc. This instrument, which without compass sells for $30, has a 10-inch telescope, one-inch aperture. The same instrument with compass sells for $38. The circular also illustrates farm levels selling for $16 and $25.

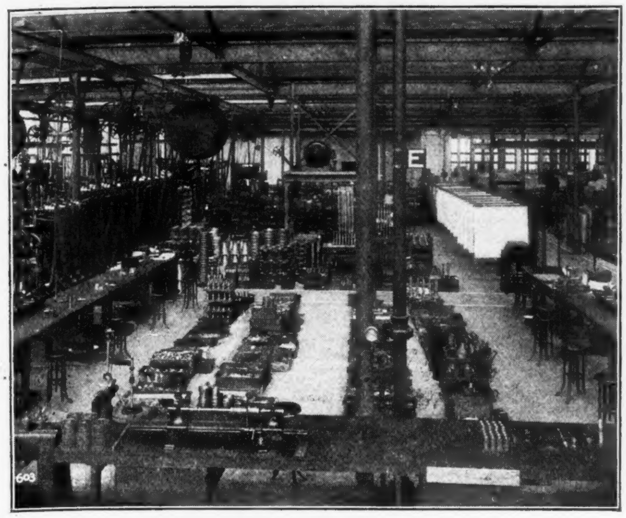
General Electric Co., Schenectady, N. Y. Booklet No. 4926 on the application of electricity to marine service. The publication is printed in colors and describes the various pieces manufactured and supplied by the company for marine use. The data given are of general interest to motor boat owners and among these data will be found reproductions of the flags of the principal yacht clubs throughout the country.

J. M. Carpenter Tap & Die Co., Pawtucket, R. I. Catalogue No. 19 on tools for cutting screw threads comprising taps, dies, screw plates, die-stocks, tap wrenches, etc. The catalogue also contains useful tables on U. S. Standard threads, V threads, International, and French standard threads, Whitworth standard threads, British Association standard, Acme standard and A. S. M. E. standard for machine screws, etc.

Rahn-Larmon Co., Cincinnati, Ohio. Catalogue of Rahn-Larmon engine, turret and gap lathes built in the following series and sizes: Series A, 16-, 18- and 20-inch engine lathes; series A, 16-, 18- and 20-inch gap lathes; series B, 18-, 20- and 22-inch engine lathes; series D, 22-, 24- and 26-inch engine lathes; series G, 24- and 48-inch extension bed gap lathes; and series F, 26-, 28-, 30- and 32-inch engine lathes.

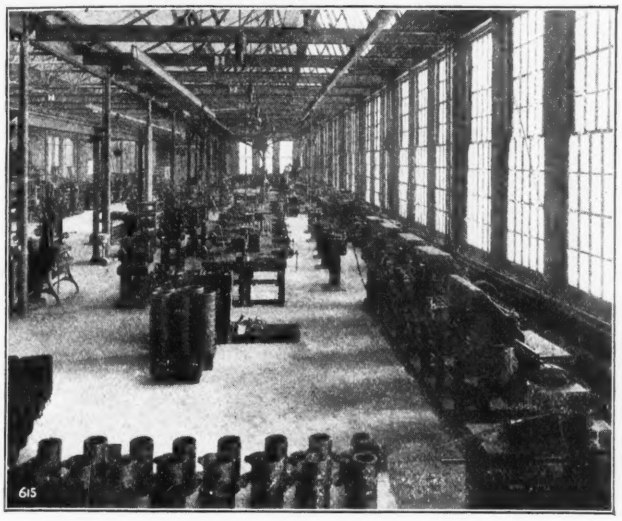
Hale-McAdams Wheel Co., 224 High Avenue, Cleveland, Ohio. Circular of the Cleveland friction clutch which is made in nine sizes,

EVERY DETAIL OF CINCINNATI MILLERS



Inspection and Routing Department.

is inspected after every operation. Some of them pass through this department as many as twenty times before they are finished. Hardened gears, clutches, and similar parts are also tested with the scleroscope and must meet definite standards of hardness set for each piece.

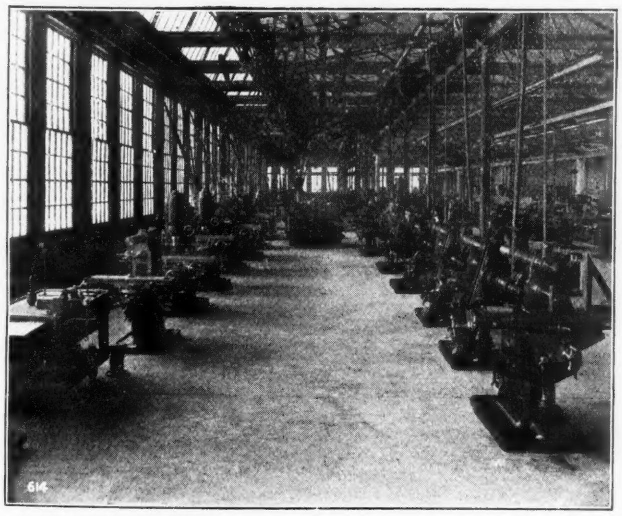


Department for Assembling and Testing Feed and Drive Boxes.

The drive box, feed box, etc., each form a complete unit of mechanism. They are assembled by skilled men who are expert on this work because they do nothing else.

Every unit when assembled, is given a running test under working conditions before passing into stock.

The completed machine must pass an exacting inspection for alignment; must run continuously for a given period; and must also do a variety of milling successfully.



Department for Testing the Completed Machines.

These running and working tests are a final check on each unit of mechanism, and are a guarantee that every detail is fully up to our high standard of excellence.

These are some of our Manufacturing Methods. Visit us and see them for yourself.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

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CONTENTS FOR MAY

The first column of page numbers applies to the Engineering and Railway Editions: the second to the Shop Edition.

ranging from 8 inches diameter to 24 inches diameter and having capacities of 8 to 63 horsepower per hundred revolutions per minute. The clutch is self-oiling, has few parts, is easily adjusted, and has other advantages of interest to all those concerned with the installation of clutches.

INDUSTRIAL INSTRUMENT CO., Foxboro, Mass. Bulletin No. 61 on portable or hand tachometers, single-spindle multi-speed spring type made by Dr. Th. Horn of Leipzig, Germany. These instruments show at a glance the rate of rotation or peripheral speed and by means of the selective speed-changing mechanism a single instrument may have several scales. One of the forms of this instrument is a cut meter for showing the cutting speed of lathe and planer work.

NEW PROCESS TWIST DRILL CO., Taunton, Mass. Catalogue of carbon high-speed and "Reliance" high-speed twist drills. The regular carbon steel and high-speed drills are hot-forged and twisted instead of being milled from the solid as is the common practice. The "Reliance" high-speed twist drills are made from profile stock inserted in a carbon steel shank by a special process. The claim is made that the hot forging process gives the drill greater strength because the grain follows the spiral fluting.

HESS-BRIGHT MFG. CO., 2111 Fairmount Ave., Philadelphia, Pa. Data Sheets, Nos. 5-A, 52-I, 65-A, 68-A, 70-A, 75, 76 and 78 on mounting collar type ball thrust bearing to take thrust in one direction only; DWF adapter bearings; centrifugal basket mountings; application of floating bushes to grinding spindles; DWF adapter and method of assembling with bearings on a straight shaft; standard form of mounting for two-bearing four-cylinder crankshaft; built-up crankshaft and two-cylinder V type motor; and mountings for rolls.

ADAMS CO., 877 Market St., Dubuque, Iowa. Circular No. 812 illustrating and describing the No. 4 Farwell universal gear hobber which was illustrated and described in the March number of MACHINERY. This gear hobber cuts spur gears, worm-wheels, spiral and worm gears, herringbone gears, ratchet wheels, sprocket wheels, etc. It has a capacity for gear diameters up to 24 inches, and with arbor support removed, up to 28 inches. The vertical feed of the head is 12 inches and the coarsest diametral pitch cut in steel is 3½ pitch, and in cast iron or bronze, 3 pitch.

CRESCENT MACHINE CO., 56 Main St., Leetonia, Ohio. Catalogue for 1912 of "Crescent" wood-working machinery comprising band saws, "Crescent" angle band saws which may be tilted for bevel sawing, guards for band saws, setting and filing clamps, saw tables, saw guards, shaper fence, single and double spindle shapers, jointers, variety woodworker, planers and matchers, surfacers, swing cut-off saws, disk grinders, universal borers, post borers, etc. A valuable feature of the catalogue is the data on the horsepower required for machines, which enables a customer to estimate the probable power requirements of machines to be installed.

W. S. ROCKWELL CO., 50 Church St., New York. Specimen views from catalogue No. 14 showing installations of Rockwell oil and gas furnaces, among which are installations of single chamber and double chamber annealing furnaces, double-end underfired annealing furnaces for brass, copper, German silver, sterling silver, etc.; single-end underfired annealing furnaces for the same fuel and purposes are shown, also annealing and hardening furnaces, carbonizing furnaces, rotary annealing and hardening furnaces, rod heating furnaces, forge furnaces, brass melting furnaces, plate heating furnaces, and soft metal furnaces, all using oil or gas fuel.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletins Nos. 4915 on direct current motors; 4921 on electric heating and cooking; 4922 on electricity in metal mines; 4923 on modern electrical equipment for economical production of iron and steel; 4928 on searchlight projections for commercial use; 4929 on electrically operated brick plants; 4933 on small polyphase motors; 4934 on battery charging rheostats; 4935 on GE-201-A railway motor; 4940 on commutating pole motors; 4941 on water flow meters; 4942 on Thompson direct current test meter; 4943 on direct current motor starting panels for heavy service; and 4944 on isolated and small plant alternating current switchboard panels.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa. Leaflets, Nos. 2362 on type CA alternating-current motors; 2409 on self-starting synchronous motors, ranging in capacity from 90 to 1500 horsepower and from 220 to 6600 volts; 2441 on the application of small motors; 2443 on motors for crane and hoist service; 2446 on type QK electrically-operated brakes for direct-current cranes and hoist motors; 2447 on type SP electrically-operated brakes designed especially for mill and crane service; 2449 on hand-operated controllers for light crane and hoist service; 2383 on alternating-current steel mill motors, type MA; and circulars Nos. 1088 on three-wire direct-current generators; 1522 on multiple unit trains and HL control; and 4049 on type F carbon circuit-breakers.

TRADE NOTES

DOEHLER DIE-CASTING CO., Court and Ninth Sts., Brooklyn, N. Y., has established a Detroit office in the Ford Bldg., Room 1313, in charge of the company's vice-president, Mr. H. B. Griffin.

E. L. ESSLEY MACHINERY CO., Chicago, Ill., has made Mr. James L. Gough sales manager and Mr. James J. Shanahan representative for Indiana and Michigan, replacing Mr. J. A. Richardson, resigned.

CANTON MACHINERY EXCHANGE, 624 N. Market St., Canton, Ohio, was recently organized to deal in machine tool specialties, and the catalogues and literature of manufacturers of machine tools and accessories are requested.

EDGAR ALLEN & CO., LTD., Chicago, Ill., formerly of 434 W. Randolph St., has moved to larger and more commodious quarters at 718-722 W. Lake St., where a full stock of all grades of Allen's tool steels will be carried.

ALLIS-CHALMERS CO., Milwaukee, Wis., which recently went into the hands of receivers, has been reorganized with a capital stock of $42,500,000. The stock consists of $26,000,000 common and $16,500,000 seven per cent accumulative preferred stock.

LUCAS MACHINE TOOL CO., Cleveland, Ohio, was awarded a gold medal and diploma at the Brussels Exposition in 1910 for the Lucas precision horizontal boring, drilling and milling machine which was exhibited by the company's representative, Mr. Alfred H. Schütte.

PAGE-STORMS DROP FORGE CO., Chicopee, Mass., has installed a thoroughly equipped chemical laboratory, modern in every respect. It is under the direction of an experienced chemist who was connected with the Halcomb Steel Co., Syracuse, N. Y., for about four years.

ANDREW C. CAMPBELL, Waterbury, Conn., will erect a factory on State St. for the manufacture of a patented self-spreading cotter-pin. The cotter-pin is so fashioned that when inserted in a hole and driven with a hammer, one part slips past the other, thus spreading their ends, and preventing the pin from falling out.

SUFFERN & SON certified public accountants, have established a branch at 1121 Newhouse Bldg., Salt Lake City, Utah, under the direction of Mr. Charles A. Secor, as resident partner. This office will have a staff of competent accountants and will also command the services and abilities of the entire organization.

JOSEPH T. RYERSON & SON, Chicago, Ill., have been appointed as sole agents for Chicago territory to represent the full line of multi-spindle drill presses manufactured by the Fox Machine Co., Grand Rapids, Mich., and a machine has been installed on the floor of the Chicago machine tool warehouse for demonstrating purposes.

HOSKINS MFG. CO., 459 Lawton Ave., Detroit, Mich., maker of Hoskins electric furnaces, pyrometers and heating appliances, and "International" electric heaters, has opened an office in the Oliver Bldg., Pittsburg. This office will enable the company to more adequately care for its rapidly growing business in the Pittsburg district.

RICKARD & SLOAN, 20 Vesey St., New York, is a newly organized advertising firm, composed of William L. Rickard and Clifford A. Sloan. The firm will give particular attention to the planning and management of advertising campaigns for firms engaged in the manufacture of mechanical and electrical apparatus and accessories.

BUFFALO FOUNDRY & MACHINE CO., 63 Winchester Ave., Buffalo, N. Y., was damaged by fire early in the morning of April 11 to the extent of about $10,000. Because of its steel and glass construction the building is practically fireproof, excepting the roof, where the greatest damage was done. The damage stopped business in the plant for only a few days.

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